NOV 28 1924

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ENGINEERING:

An Illustrated Weekly Journal.

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VOL. CXVIII.—No. 3072.] LONDON: FRIDAY, NOVEMBER 14, 1924. [Registered at the General Post Office as a Newspaper.] [PRICE ... 1s. BY FOREIGN POST 1s. 3½d.

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PATENT WATER-TUBE BOILERS.
AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

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OF ALL DESCRIPTIONS.
FLOATING CRANES. COAL BUNKERING VESSELS.
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See half-page Advert. last week and next week. 2087

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See Advertisement last week, page 19.

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Tank Locomotives.
Specification and Workmanship equal to Main Line Locomotives.
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Hammers, Presses, Furnaces,
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PLANT AND MACHINERY
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Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 2257
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See Advertisement, pages 33 and 91, Nov. 7.

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SHALLOW DRAFT VESSELS. 2276

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Worm Wheels cut up to 13 ft. diam.
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Systems
PRESSURE, AIR, STEAM
For Boilers of all types.
KHRMODES LIMITED,
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Naval Outfits a Speciality,
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GENERATING SETS, Totally Enclosed, Three Crank Self-Lubricating Engine, with Complete Condensing Plant, by Allens, Pipes, Valves, Oil Separator, Etc., complete.
Admirably suited for Mining or other power transmission work.
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MECHANICAL ENGINEERS,
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AND
Steel Plates.
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See Advertisement, page 87. 1872

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PETERBOROUGH.
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AIR COMPRESSORS.
REFRIGERATING PLANT. 1475
See Advertisement, page 51, Nov. 7.

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GROUND extending to 42,672 square yards, and BUILDINGS thereon of Engine and Boiler Shops (lately belonging to Messrs. DUNSMUIR & JACKSON, Ltd.), equipped with Overhead Travelling Cranes up to 60 tons.
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"Capable of remarkable work"—*Dr. Rogers.*
"Ease of manipulation in high power work." Moderate cost. Brochure "C" with photographic specimens free from:—
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LAND AND MARINE
YARROW BOILERS. 2277

Matthew Paul & Co., Ltd.
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LEVENFORD WORKS, 2219
See Full Page Advt., page 59, Nov. 7.

Forgings.
Walter Somers, Limited,
HALESOWEN. 7116

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For Production of SHEET METAL WORK, COINAGE, CARTRIDGES AND GUNPOWDER.
Foundry, Works and Showrooms: BIRMINGHAM.
See Advert., page 57, Nov. 7. 8195

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Forgings, Castings, Bars, Sheets, Wire, Tubes.
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CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 1946

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SPECIAL MACHINERY, try
THOMAS HUNT & SONS,
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For Paraffin and Crude Oil
Sizes 1½ B.HP. and upwards.
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PATENTS. DESIGNS. TRADE MARKS.

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For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.

Chief Engineer: C. E. STROMEYER, M.I.C.E.

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PATENTS AND DESIGNS ACTS, 1907 AND 1919.

Notice is Hereby Given that

Edward Charles Robert Marks, of 57 & 58, Lincoln's Inn Fields, London, W.C.2, seeks leave to amend the Specification (including drawings) for Letters Patent No. 219622, entitled "Train Control Apparatus."

Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents), issued on the 5th November, 1924.

Any person, or persons may give notice of Opposition to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton Buildings, London, W.C.2, within one calender month from the date of the said Journal.

W. TEMPLE FRANKS,
Comptroller-General. G 341

The Institution of Structural ENGINEERS.—EXAMINATIONS.

The Next Examination for GRADUATESHIP and ASSOCIATE-MEMBERSHIP will take place at Centres to be arranged, on Wednesday (Graduateship), Thursday and Friday (Associate-Membership), DECEMBER 3, 4 and 5, 1924. Syllabus and entry form from the undersigned. Closing date for entries November 25th.

MAURICE G. KIDDY, F.I.S.A.,
Secretary.

Abbey House,
Westminster, S.W.1. G 399

Correspondence Courses for

Inst. Civil Engrs., Inst. Mech. E., London Univ. (Matric., Inter., B.Sc.), Inst. M. & Cy. E., and ALL ENGINEERING EXAMINATIONS personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours) Eng. London, Assoc. M. Inst. C.E., Chartered Civil Engineer, M.R.S.I., F.R.S.A., etc. Also Day Tuition in Office. Excellent results at all Exams., comprising hundreds of successful Students. Courses may commence at any time, and all Students receive individual tuition.—For full particulars apply to 8/11, TRAFFORD CHAMBERS, 58, SOUTH JOHN STREET, LIVERPOOL. 1993

Engineering Salesmanship

and SALES MANAGEMENT.—Write for brochure describing our special Course of Training for posts of unlimited scope in this lucrative field.—DIRECTOR, Institute of Engineering Salesmanship, 333, Oxford Road, Manchester. 2481

Engineering Drawing.—

Special Postal Course in Engineering Drafting. Enrol now. Fee Three Guineas for the completd course. Also day tuition in Office by qualifice teacher. Established in 1895.—PERCY PITMAN, M.I.Mech.E., 29, Victoria Street, London, S.W. 1. 2247

TENDERS.

THE GREAT INDIAN PENINSULA RAILWAY COMPANY, 45, COPTHALL AVENUE, LONDON, E.C., invite

Tenders for :—

1. 4-WHEEL OPEN and COVERED WAGONS and CARRIAGE UNDERFRAMES. Fee £1.

Tenders are due by Eleven a.m. on 9th December, 1924. Tender forms obtainable at above address. Fees not returnable. G 397

G. R.

GOVERNMENT SURPLUS.

TRANSFORMERS

LYING AT H.M. FACTORY, GRETNA.

For Sale by Public Tender.

Owing to the urgency of clearing the area, we are offering for sale by Tender, a large number of Transformers of all sizes up to 1000 K.V.A., 6300/440 VOLTS, 3-PHASE, 50 PERIODS.

CLOSING DATE OF TENDER HAS BEEN POSTPONED UNTIL DECEMBER 1st.

Particulars and Forms of Tender from

GEORGE COHEN & ARMSTRONG DISPOSAL CORPORATION, Abbey House, 2, Victoria Street, Westminster, S.W.1. G 396

Tel. No. Telegrams:
Victoria 6040/4. "Cohstrong, Sowest."

STATE ELECTRICITY COMMISSION OF VICTORIA,
Melbourne,
Victoria,
AUSTRALIA.

Tenders are Hereby

Invited for the SUPPLY, DELIVERY, etc., of the following for the Yallourn Power Scheme.

Copies of Tender Form and Specification will be available on application to :—

AGENT GENERAL FOR VICTORIA,
Melbourne Place, Strand,
London, W.C.2.

SPECIFICATION No. 25/1—6,000 V. TRANSFORMERS AND SPARES.

CHARGE :—£1 1s. for the first three copies of Tender Form, Conditions of Contract, and Specification complete. This charge will be returned on receipt of a *bona fide* Tender. A fourth copy and any further copies will be supplied for the sum of 5s. each. This charge is not returnable.

PRELIMINARY DEPOSIT :—A Preliminary Deposit of £50 is to be lodged with Tender.

The Specifications may be inspected at the above mentioned office.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than Five p.m., 19th January, 1925.

R. LIDDELOW,
Secretary. G 331

The Director-General,

India Store Department, Branch No. 16, Belvedere Road, Lambeth, S.E.1, REQUIRES :—

ELECTRICAL FITTINGS for Railway Carriages. Tenders due on the 2nd December, 1924.

Tender Forms obtainable from above. G 395

GLASGOW CORPORATION TRAMWAYS.

STEEL RAILS AND FISHPLATES.

The CORPORATION of GLASGOW are prepared to receive

Tenders for the Supply of the

undernoted :—

2500 Tons STEEL TRAMWAY RAILS, No. 8 B.S. Section.

500 Tons STEEL TRAMWAY RAILS, No. 8 C Section.

100 Tons FISHPLATES FOR ABOVE.

Specifications, Forms of Tender, and Drawings can be obtained on application to Mr. JAMES DALRYMPLE, General Manager, 46, Bath Street. Sealed Tenders, marked outside, "Tramways—Tender for Steel Rails," must be lodged with the Subscriber on or before Tuesday, 25th November.

The lowest or any Tender may not be accepted.

J. LINDSAY,
Town Clerk.

City Chambers,
Glasgow.
11th November, 1924. G 385

METROPOLITAN ASYLUMS BOARD.

TO ENGINEERS, ELECTRICANS AND OTHERS.

The Board invite separate

Tenders for :—

(A) EASTERN HOSPITAL EXTENSION. INSTALLATION of TWO INDEPENDENT HOT WATER BOILERS for supplying Nurses' Home.

(B) DARENTH TRAINING COLONY. INSTALLATION of FORCED CIRCULATION HOT WATER SUPPLY APPARATUS in Schools section.

(C) COLINDALE HOSPITAL. (1) INSTALLATION of new FUEL ECONOMISER; (2) BRICKWORK SETTINGS for Economiser and Building work; (3) NEW STEAM and FEED MAINS, etc.

(D) ST. ANNE'S HOME. INSTALLATION of HEATING APPARATUS.

(E) WESTERN HOSPITAL. ALTERATIONS and EXTENSIONS to ELECTRIC LIGHTING in WARDS.

In accordance with the Specifications and Drawings prepared by Mr. T. COOPER, M.Inst.C.E., M.I. Mech.E., Engineer-in-Chief. The Specifications, Drawings, and Forms of Tender may be inspected at the Office of the Board, Victoria Embankment, E.C.4, on and after Ten a.m., Tuesday, 18th November, 1924, and can then be obtained upon payment of a deposit of £1 in respect of each work. The amount of the deposit will be returned only after the receipt of a *bona-fide* Tender sent in accordance with the instructions on the Form of Tender and after the Specification and the Drawings have been returned.

Tenders addressed as noted on the Form must be delivered at the Office of the Board, not later than 2.30 p.m. on Wednesday, 3rd December, 1924.

G. A. POWELL,
Clerk to the Board.
G 384

GREAT SOUTHERN & WESTERN RAILWAY (IRELAND).
CONTRACTS, 1925.

The Directors of the Great Southern and Western Railway Company are prepared to receive

Tenders for the Supply of the

undermentioned STORES for Six Months commencing 1st January, 1925.

	No. of Form.
Acid, Sulphuric ...	30
Asbestos Sheeting, etc.	40
Baskets	10
Bolts, Nuts and Rivets	15
Brooms and Brushes	13
Brass Fittings for Carriages... ...	18
Do. do. for Water	26A
Do. do. for Gas ...	26B
Canvas and Sacks ...	6
Canvas for Wagon Tarpaulins	8A
Castings, Mall. Iron	11
Carriage Laces ...	7A
Cloth for Carriages	7c
Clothing, I.R. proofed	9B
Coach Screws and Washers	15
Colours	2
Corks	39
Cotton Waste ...	5A
Crucibles	41
Drysalteries	3
Emery and Glass Cloth, etc. ...	28
Files and Tool Steel	20
Fire Bricks and Clay	33
Foundry Requisites	42
Galvanized Sheets, Buckets, etc. ...	23
Grates, Stoves ...	24
Grindstones	28
Glass, Sheet, and Plate	27A
Glass and China Sundries	27B
Hardware (Sundry)	17
India Rubber Goods	9A
Implements, Sundry	21
Iron Tubes and Fittings	29
Leather and Leather Goods	12
Locks and Keys ...	19
Mantles for Gas ...	26C
Mats, Fibre	10
Nails	31
Nuts, Hex., Black and Bright... ...	15A
Packings	40
Plumbago	41
Railway Fastenings	16
Rain Water Pipes and Gutters	25
Ropes, Twine & Flax	4
Soaps	38
Sewer Pipes, Plaster of Paris, etc. ...	32
Shovels, Spades, etc.	21A
Sponge Cloths ...	5
Signal Wire Pulleys	11
Screws and Split Pins	14
Tin Plates	22
Waste	5A
Waterproof Clothing	9B
Wicks	5
Wire, Fence and Signal	30A
Wirework	30B

Forms of Tender can be obtained on PAYMENT of 6d. each from the STORES SUPERINTENDENT, GENERAL STORES DEPARTMENT, G.S. & W.R., INCHICORE, DUBLIN. Applications for forms by Post must be accompanied by Postal Order. Stamps cannot be accepted. All enquiries for information should be also directed to the Stores Superintendent.

Patterns may be inspected at the General Stores Department on and after the 14th inst., between the hours of Ten a.m. and Four p.m. (except on Saturdays).

Tenders must be enclosed in the special envelope supplied for the purpose with each schedule, and must be posted so as to be with the undersigned before Ten a.m., on Tuesday, 25th November, 1924.

The Directors will not consider any Tender unless it is furnished on the Company's Form, and do not bind themselves to accept the lowest or any Tender. By Order,

C. E. RILEY, Secretary.

Kingsbridge Terminus, Dublin,
November, 1924. G 359

BOMBAY, BARODA & CENTRAL INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Friday, 5th December, 1924,

Tenders for the Supply of :—

1. LOCOMOTIVE BOILERS,

and up to noon on Friday, 28th November, 1924, Tenders for the supply of :—

2. STEEL MATERIAL.
3. WROUGHT IRON (Flats & Rounds).
4. PIG IRON.
5. FERRO MANGANESE and FERRO SILICON.

Tenders must be made on forms, copies of which, with Specification, can be obtained at these Offices on payment of 20s. each for Nos. 1 and 2, and 10s. each for Nos. 3, 4 and 5 (which will not be returned). The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices: The White Mansion,
91, Petty France,
Westminster, S.W. 1.
12th November, 1924. G 398

STATE ELECTRICITY COMMISSION OF VICTORIA,
Melbourne,
Victoria,
AUSTRALIA.

Tenders are Hereby

Invited for the SUPPLY, DELIVERY etc., of the following for the Yallourn Power Scheme.

Copies of Tender Form and Specification will be available upon application to :—

AGENT GENERAL FOR VICTORIA,
Melbourne Place,
Strand,
LONDON, W.C. 2.

SPECIFICATION No. 25/2,
VOLTAGE REGULATING APPARATUS.

CHARGE :—

10s. for the first two copies of Tender Form, Conditions of Contract, and Specification complete. This charge will be returned on receipt of a *bona fide* Tender. A third copy and any further copies will be supplied for the sum of 5s. each. This charge is not returnable.

PRELIMINARY DEPOSIT :—

A Preliminary Deposit of £5 is to be lodged with Tender.

The Specifications may be inspected at the above mentioned Office.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than Five p.m., 19th January, 1925.

R. LIDDELOW,
Secretary. G 320

APPOINTMENTS OPEN.

MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY.
(Faculty of Technology in the University of Manchester).

APPOINTMENT OF ASSISTANT LECTURER IN MECHANICAL ENGINEERING.

The Governing Body invites

Applications for an Assistant

LECTURESHIP in Mechanical Engineering in the College of Technology.

Salary: £300 per annum.

Conditions of appointment and form of application may be obtained from the Registrar, College of Technology, Manchester. The last day for the receipt of applications is Monday, 1st December, 1924.

Canvassing, either directly or indirectly, will disqualify a candidate for appointment.

B. MOUAT JONES,
Principal of the College. G 374

Overseer Required by

the GOVERNMENT of HONG KONG, Public Works Department, for three years with possible extension. Salary £320—£10—£360 a year, payable locally in dollars at the Government rate of exchange, at present fixed at 2s. to the dollar. In addition a strictly temporary exchange allowance of 20 per cent. of salary is at present paid, and thus at the present time the annual salary in dollars will be $3840 a year. The current rate of exchange being now about 2s. 4d. to the dollar, the sterling equivalent of $3840 is about £448 a year. No Income Tax is payable. Candidates, age 25 to 35, must have had experience as Clerk of Works or Foreman of Works in the construction of quay walls, jetties or wharves in stone and/or concrete, and must be able to read plans and make measurements of completed work.—Apply at once by letter, stating age and experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W.1, quoting at head of letter M/12608. G 365

Assistants (Three)

REQUIRED by the GOVERNMENT of HONG KONG for service in the ARCHITECTURAL OFFICE of the PUBLIC WORKS DEPARTMENT for a period of three years with possible permanency. Salary £400 rising by annual increments of £20 to £500 a year, and thence (if appointment is made permanent) to £950 a year, payable locally in dollars at the Government rate of exchange, which is at present fixed at 2/- to the dollar. In addition a strictly temporary exchange allowance of 20% of salary is at present paid, and thus at the present time the annual salary in dollars will be $3520 a year. The current rate of exchange being now about 2s. 5d. to the dollar, the sterling equivalent of $3520 is accordingly about £667 a year. No income tax payable. Candidates, unmarried, 24 to 33 years of age, must be duly qualified Architects Assistants and Associates of the R.I.B.A., should be experienced in design and the preparation of working drawings, details and Specifications, and have some knowledge of quantities. Experience in the design and erection of steel framed buildings, and a working knowledge of reinforced concrete is desirable.—Apply at once by letter, stating age, qualifications and experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W.1, quoting M/12919. G391

Shipyard Manager Wanted

to take entire charge under general management; must have experience in estimating, designing and construction of merchant vessels. State age, experience (in detail) and salary expected. —Address, VESSELS, WM. PORTEOUS & Co., Advertising Agents, Glasgow. G 356

An Established Engineering

Firm in London REQUIRES the SERVICES of One fully qualified to open, develop and manage a new branch. Applicants must be acquainted with and capable of handling both the technical and commercial side of welding in all its branches. First-class credentials essential. A complete resume of experience must accompany replies. Age and salary required to be stated. Metallurgical qualifications preferred.—Address, G 360, Offices of ENGINEERING.

Assistant Works Manager

WANTED for modern works near London, manufacturing high grade electrical apparatus and telegraph instruments. Must have had experience in the class of work and be able to control staff and workmen and be familiar with up-to-date methods of manufacture and have had a good scientific training.—Address, stating age, experience and salary required, to G 342, Offices of ENGINEERING.

Wanted, Sales Manager,

Building and Kindred Industries.—A London house of manufacturers requires the services of a gentleman who is an expert Sales Manager and organiser. The product is a technical one selling to Architects, Structural Engineers, Builders, Builders' Merchants, Contractors, etc., and acquaintanceship in these spheres together with experience or knowledge of concrete construction and/or structural engineering would be an advantage. State age, full qualifications, sales managership experience, if capital available, etc., in strict confidence.—Address, G 381, Offices of ENGINEERING.

Engineering Assistant

WANTED. Must have good Scientific and general engineering training and be competent to interview, exploit for orders and arrange for their execution. Man with good personal knowledge of Industrial Engineering firms preferred. Age not over 35.—Address, SCIENTIFIC, WILLIAM PORTEOUS & Co., Advertising Agents, Glasgow. G 387

PORTSMOUTH WATER COMPANY.

ENGINEERING ASSISTANT.

Permanent Engineering

ASSISTANT, about 25 to 30 years of age REQUIRED by the Borough of Portsmouth Waterworks Company, as early as possible in the new year. Applicants must have a good knowledge of Waterworks design and construction, both practical and theoretical, and must also be good Surveyors and Draughtsmen. Previous personal experience in Waterworks maintenance, including pumping machinery, would be an advantage, and an Associate Member of the Institution of Civil Engineers would be preferred. Salary £350 per annum, rising annually, by £25 to £450.—Applications on Forms which will be provided on application to the ENGINEER and GENERAL MANAGER, Waterworks Company, Portsmouth, must be delivered not later than Friday, December 12th, next. G 384

COUNTY BOROUGH OF BRIGHTON.

WATERWORKS DEPARTMENT.

APPOINTMENT OF ENGINEERING ASSISTANT.

The Council invite

Applications for the Appointment of ENGINEERING ASSISTANT in the Waterworks Department at a salary of £400 per annum; the appointment to be for a period of three years in the first instance.

Applicants, who should have passed the Associate Membership examination of the Institution of Civil Engineers, must have considerable experience in the design and layout of modern pumping plants, buildings, service reservoirs and mains, and preference will be given to candidates who have had a mechanical training.

Applications, in the candidate's handwriting, stating age, training, experience, qualifications, and present occupation, together with copies of three recent testimonials, should be forwarded to the undersigned, endorsed "Engineering Assistant, Waterworks Department," not later than 22nd November, 1924.

Further information as to the appointment may be obtained from Mr. A. B. CATHCART, M.Inst.C.E., Waterworks Engineer, 19, Bond Street, Brighton.

JAS. H. ROTHWELL,
Town Clerk.

Town Hall, Brighton.
4th November, 1924. G 318

CITY OF BIRMINGHAM EDUCATION COMMITTEE.

MUNICIPAL TECHNICAL SCHOOL.

HEAD OF ENGINEERING DEPARTMENT.

The Education Committee invite

Applications for Appointment to the POST of HEAD of the ENGINEERING DEPARTMENT of the Municipal Technical School. The post is a full-time one and the salary scale is £850 per annum, rising, subject to satisfactory service, by annual increments of £50 to £900 per annum.

The above-mentioned salary will be subject to a deduction of 5 per cent. in respect of the voluntary abatement of salaries, and also to the usual deduction of 5 per cent. in respect of contributions to the School Teachers' (Superannuation) Acts.

Particulars of the duties and conditions of the appointment, together with form of application, may be obtained from the Principal, Municipal Technical School, Suffolk Street, Birmingham, or from the undersigned.

Canvassing will be a disqualification.

P. D. INNES,
Chief Education Officer.

Education Office,
Margaret Street,
Birmingham.
7th November, 1924. G 307

LITERATURE.

Automatic Telephone Systems. By WILLIAM AITKEN, M.I.E.E., A.Am.I.E.E. Vol. III. *Large Multi-Office Automatic Systems; Semi-Automatic Working; Miscellaneous Systems: Lay-Out and Wiring; Power Plant.* London: Ernest Benn, Limited. 1924. [Price 55*s.*]

WITH the appearance of the third volume, dealing with the suggested mechanism for automatic connection and control, Mr. Aitken completes the task he contemplated, and we offer him our congratulations on the successful accomplishment. This, of course, is very different from saying that finality has been reached. Even in this volume, there are additions to the descriptions given in earlier sections. We are at the beginning and not the end of the many interesting problems that will long engage the attention of engineers, who have fearlessly fought their way through bewildering complications and built up circuit on circuit, and control on control, till mechanical operations wear the appearance of intelligent direction. Simplification will, however, proceed continuously and ingenuity will devise other and less complicated devices, while the necessity for standardisation will work in the same direction. Already, there are several competing systems occupying special fields, and active competition among these will tend to improved working. The Strowger-Director system apparently enjoys the confidence of our Post Office authorities. The Rotary and Radial systems are more favoured on the Continent, and the Panel system due to the enterprise of the Western Electric Company of the United States satisfies the needs of large areas and enjoys a wide field of usefulness. The main principles involved in those methods have been described and illustrated in the earlier volumes.

In considering the arrangements in use or suitable for large multi-office areas, it is instructive to notice that experience has not yet been able to decide whether small switches of, say, 100 lines, or larger switches with 500 lines, are, more convenient and economical. The Automatic Telephone Manufacturing Company of Liverpool claim that the Director System, a variation of the Standard Strowger equipment, furnishes all the necessary advantages and facilities for large areas. On the other hand, the Western Electric Company followed by the Ericsson Company of Sweden, approve of a 500 rotary and radial system. The telephone department of the Post Office has apparently tried both, and after trial decided in favour of the small switch. The facilities and, we presume, the difficulties, of passing from manual to automatic devices are about equally balanced in either case. A fundamental difference lies in the method of driving, and this may prove the determining factor in the opposing systems. The Strowger system is driven by a step-by-step mechanism, whereas in the arrangements of the other Companies, the switches are driven by bringing their mechanism into engagement with continuously running shafting.

The ease and comfort of the user will depend greatly on the working of the dial, the mechanism by which a fellow subscriber can be summoned. By moving the dial numbers, he brings into action the gear that controls the selecting and connecting switches, but with this apparatus he has nothing to do, his power for action or interference ends with the movement of the dial figures into their proper places. Much attention must have been given to this point, and yet the process seems to be unduly elaborate. Seven operations are necessary to complete the call, three to attract the exchange, and four to call the subscriber, who will be designated by four digits. An unnecessary complication seems to be retained by adhering to the use of a descriptive name for the exchange, compelling the subscriber to translate three letters of the name of the exchange into figures. The necessity for this extra operation is not clear. Instead of taking from the Telephone Directory the name of the exchange, as Mayfair or Wimbledon, it is necessary to code the first three letters into 629 or 946. Possibly it is found in practice that the retention of seven digits in the memory for a few moments is too troublesome for many people. Certainly the process is very fully explained and the length of explanation may have conjured up difficulties that do not exist. Abandoning a call, or taking measures to obtain access to an operator need provision to be made by special devices which are shown in diagrams, fascinating by the amount of detail exhibited and explained.

The passage from manual to automatic working in a centre like London must be long and tedious, involving a transition period, during which both methods may be employed. The working of the "call indicator," a marvellous piece of mechanism that makes final adjustment possible, will be set up at all manual offices within a 10-mile radius of the central tandem office in Holborn. All the outlying offices will have outgoing and incoming trunks to the tandem office, where the incoming trunks will be received on call indicator equipment. Of these outlying stations, some will combine three offices each containing 10,000 lines, and this may serve to indicate the extent of the accommodation required at the central tandem office. As completion proceeds, so a subscriber will be enabled by turning his dial to transmit any call automatically to any one of the manual offices in the area. When two or more automatic offices are installed, there will be direct trunks between them, and between these main offices and their satellites, so that calls from one of these to another will be strictly automatic.

Modifications of recent introduction into the panel system are adequately explained, but the translational facilities and flexibility of the system are apparently not superior to those of the Director system. The length of life and cost of maintenance are factors that cannot be estimated by the examination of diagrams, however ingeniously constructed, and these are elements which will eventually decide the choice of method and the direction of improvement. The Ericsson system has some interesting features that will secure its recognition. It utilises register and sequence switches in addition to pre-selectors or line finders, group selectors, and final selectors. Mr. Aitken calls special attention to the advantages arising from the construction of the three classes of switches to practically a similar design. An outcome from the Ericsson system due to Mr. D. C. Crowe of that company, is an invention for utilising plugs and cords in connection with a tubular cage, having jacks arranged in a circle located at either end. We do not know that the plan has found any extensive application but it can be readily adjusted to existing forms of automatic telephony.

Several other systems are described, particularly those adapted to bridging over the interval between the removal of a manual system and the adoption of complete automatic arrangements. Of special interest is the adaptation of the Western Electric Company's rotary system to the Hull Municipal Telephone Exchange, since the plan does not follow that adopted by the Post Office, thus permitting independent comparison. A scheme is also submitted for working between a main and a branch office, where it is undesirable to have an operator in constant attendance. In this way an office can be closed at night, and yet be utilised for transmission.

Much ingenuity is shown in the matter of metering and some of the schemes are simple in construction, and should give confidence to the public. Some, more ambitious, aim at recording the duration of the connection, others regulate the charge proportionately to the amount of apparatus and number of lines involved. This latter plan is advocated by Messrs. Laidlaw and Grinstead, who urge that a tariff to be satisfactory, should be proportioned to the expenses, and arranged on the principle that the cost incurred in giving the service rendered on each call, should be covered by the revenue received in respect of that call. The plan proposed is one that concerns the public very narrowly, and the proposers maintain that it is scientific and fair, and is allied to the methods in use of charging for electricity and gas. It is no part of the author's scheme to enter into costs or capital expenditure, but this point cannot be absent from the mind of many when they consider the additional amount of apparatus that will have to be provided.

The book concludes with a valuable section on wiring, lay-out, and power plant. In connection with the first, we are shown the expedients devised to increase the traffic-carrying efficiency of groups of electro-mechanical switches. No mention has here been made of the author's original work on details, but this omission may be corrected in some measure by calling attention to his "graded multiple trunk wiring system," for which it is claimed, that smaller switches can be used, and pre-selectors rendered unnecessary, while no distribution board is required, while the number of trunks can be readily increased to meet the demands of traffic growth. Of lay-out schemes, examples are given of the Siemen's method at the Grimsby Exchange; of Keith's method of wiring between switches in an office, of the Portsmouth Post Office; and of an American Exchange, in which a room 75 ft. long by 53 ft. wide, is made to accommodate a 10,000-line equipment. Many important topics are discussed in these last chapters, which must be passed over for want of space. In reviewing a volume crowded with details, which examines the development of schemes on which much ingenuity has been expended, it is difficult, if not impossible to do justice to the industry and labour that has collected and arranged so much material. But we can assure those who are interested, that in these volumes will be found a vast mass of information, carefully sifted by one who from experience and aptness is well qualified to supply a clear and comprehensive view of an intricate subject.

Motor Bodywork: The Design and Construction of Private, Commercial and Passenger Types. By HERBERT J. BUTLER. With foreword by Sir H. Austin, K.B.E., M.P. London: W. R. Howard & Co. [Price 52*s.* 6*d.* net.]

THE substitution of the self-propelled vehicle for the horse-drawn carriage has necessitated changes of more consequence to the manufacturer than are apparent to the public, while the abandonment of much long-acquired experience has been neither warranted nor advantageous. The evolution was too sudden and abrupt, and the advocate of the new form of locomotion was too insistent and too little instructed in the practice of the past. Modifications of the chassis compelled frequent changes in body construction that had to be hastily met. Carriage design may now be said to have thoroughly accommodated itself to the new order and has come into its own. Utility, elegance, and economical construction go hand in hand, and no material alteration is probable in modern bodies unless some entirely new design of chassis is proposed, such as relegating the engine to the back of the frame, an arrangement that was adopted, Mr. Butler reminds us, in the earliest cars. From the body makers' point of view, such a radical change would not be without its advantages. In the forward position of the engine a comparatively large portion of the chassis is occupied before the driving seat can be plotted out, and he sees the possibility of the engine being built into the body so that it is about centrally placed over the hind axle, or even wholly behind it.

Although the author may look forward to the problems of the future, or backward as a critic to note how inconveniences have been remedied and improvements introduced, naturally his main object is to serve as a guide to the present. The provision of an authoritative and comprehensive treatise is a necessity, both to inform those who have remodelled their workmanship to meet the conditions arising from the tendency to replace wood by metal, and to demonstrate the possibility of methods which will enable greater speed to be secured with less weight of material, without leading to rapid deterioration. Especially is he interested in the adoption of the principle of standardisation of parts as the best means of benefiting the public at large, by supplying the demand for the smaller types of motors of good appearance at a moderate price. We all know that a body car made singly costs twice as much as one which is part of a batch of fifty. The chassis makers are responsible for much of the irregular variety that exists. They have, perhaps, been inclined to regard the office of the body maker as inferior to that of the engineer, and have concentrated attention on their particular aims, with insufficient regard to the requirements of the body makers. If, says the author, half a dozen chassis are selected at random, each of the same rated horse-power and designed for the mounting of a similar range of body work, a comparison of the dimensions

will disclose large variations. Taking examples from six chassis of 11·9 h.p., he finds that the wheel diameter will vary from 710 to 760 mm.; the wheel base from 8 ft. 6 in. to 9 ft. 8 in.; and the wheel track from 4 ft. to 4 ft. 7 in. Such variations operate very adversely to the body builder, as they prevent him from organising his work economically or from building stock when orders are scarce. Mr. Butler looks forward confidently to the time when there will be closer co-operation between the chassis designer and the body maker.

It would be impossible to give an adequate idea of the wealth of detail described; or to note the endless variety of equipment required by the motor cars that thread our streets or are to be seen in every lane and highway, though in this minuteness the professional will find the great value of the book. He has before him the history of successful experiment, illustrated by many ingenious and practised hands, for every variation of design may be considered as an original experiment, inviting to further modification and improvement. A very happy feature is the contribution of many competing firms, who have readily supplied drawings and descriptions of their most satisfactory models. The result has the appearance of a sincere effort to get the best, and that which is most suitably adapted to a particular form of chassis or to achieve a particular end.

The author takes a wide view of his subject. He includes a description of wood-working machines and tools, hand or power driven, though of course these are used in other trades. He considers at some length the comparative merits of wood and metal, describing the various materials of construction that pass through the body makers' hands. Complicated forms of curves given to steel and aluminium panels in modern machines have done much to eliminate the use of mahogany and other decorative woods, and brought new trades and methods into existence. The bewildering variety of trimming and ornament that fashion dictates or wealth commands receives minute attention.

The motor car is, however, only one, and not necessarily the most, important branch of the subject. The facilities afforded to road transport by the commercial car in its many forms are everywhere apparent. In one direction the omnibus, the taxi-cab, the char-a-banc, compete with and supplement the work of the passenger railways; while on the other, the commercial car in great variety is being adapted to fresh purposes every day. The platform lorry in its crudest construction of a flat loading platform and a driver's cab, has assumed many shapes and grows more and more differentiated as it is made to satisfy the requirements of many trades. In turn, it becomes the box-van, the tipping wagon, the travelling caravan, the picturesque advertisement, the ambulance, and finally the hearse.

We see all these vehicles under construction, and are directed to the various forms that contribute to a satisfactory result. But in the many classes of carriages that are built upon paper, the author does not forget the æsthetic side. He enforces the production of what is pleasing to the eye as well as convenient in use. One cannot expect originality of design in a platform lorry, but though it may be used for heavy work or be soiled quickly from the nature of its contents, there is no reason why it should have an ugly outline. A body is not without dignity because it is made up of straight lines and flat surfaces, but the introduction of a line that does not harmonise with surrounding parts, or is an unnecessary addition, is detrimental to good effect. The book can be recommended to all who are desirous of acquiring further information concerning the problems of body work design.

Management Engineering. By P. F. WALKER. London: McGraw-Hill Publishing Co., Limited. [Price 17*s.* 6*d.* net].

PROSPECTIVE readers generally expect the title of a technical book to give a fairly accurate indication of the nature of its contents, and the readers of the book under review here might reasonably expect to find in it a treatise discussing the management of engineering works and giving information that would be helpful to managers or prospective managers. In two directions, the reader is likely to be disappointed. In the first place, the author states, quite frankly, that "the book is the result of an attempt to bring together material which has been treated in many separate volumes," the aim being "*to make this material available in the classroom* (the italics are ours) rather than to present new facts or distinctive ideas." In the second place, it appears that it is not the author's intention to confine himself to the consideration of the very wide subject of engineering works management. While it is not made too clear, it seems that the idea is to give works management itself a new title, to call it "management engineering," treating the management of any productive works as being a branch of engineering even as civil, electrical and mechanical engineering are separate branches. "Management engineering is a term coming into more general use to describe the activities of developing and operating production plants. While frequently thought of as being the same as industrial engineering, it reaches beyond the direct problems of production and process, into the fields of administration. . . . Production engineer, production manager and industrial engineer are three titles having similar meanings but with slight differences of some significance, all coming within the scope of management engineering." This indicates the author's point of view. In the same chapter, which is entitled "Basic Principles," useful reference is made to the various considerations which ought to be given when deciding upon the location of a plant, such as the supply of raw material and of labour and the influence of climatic conditions. Industries are classified in groups, although this appears to be a matter of interest rather than of use, and three pages of statistics are given indicating the number of people employed in the United States, in many industries, since the year 1880. There are chapters on the "Analysis of Production Factors," "Preliminary Design," in which appears to be treated the suitability of a locality for the establishment of a successful business; on the "Functional Design of the Enterprise," in which information is given on the metal-working industry, engineering, iron and steel, portland cement, leather tanning, paper and wood pulp, paper, sugar refining, starch and glucose, fur-felt hats, woollen and cotton goods. The "Design of the Plant" is then discussed, lay-outs for die-casting, gasolene engine building and cotton mills being given. Organising and financing a company are given separate chapters, these being followed by "Organisation and Management" and "Costs," a number of charts being given.

Superficially, it may be said the ground is well covered. As indicated, many aspects of works management are discussed but, if only because of the breadth of the subject, the treatment given cannot be more than superficial, and as far as this can be of value, as it can well be for class-room students who perhaps have not learnt the alphabet of management, it is to be found here *par excellence*. The quotations made by the author are many, and when space does not allow for fuller information to be given, the reader is referred to a book in which this can be found. As examples of that which the author conceives to be of value the following are quoted. Under starch and glucose the reader is informed that "Washing-corn from the storage bins is carried by conveyor to plain tanks fitted with motor-driven agitators. Floor space 300 sq. feet; fourth floor; 2 h.p. motors." Under the heading of "Fur-felt hats" it is stated that to manufacture "250 dozen soft hats per day there will be used annually about 120 tons of rabbit fur and 20 tons of other material, . . . Large quantities of hot water are used." This is interesting without doubt, even useful to a man who has time to wade through a book on "management engineering" in order to obtain a smattering of information on many subjects which will be all too little to be of value to a "managing engineer" even though he be a chemist as in some cases he should be.

We have referred before to the ineffectiveness of books in which too much is attempted within the covers of one volume. Specialisation in industry is bound to be followed by specialisation in books and, while it is apparently the author's idea to specialise in management, we feel he has not made the best use of his opportunity. That works management requires lifting on to a higher plane we have no doubt; it has been regarded all too lightly, not less, in some cases, by managers themselves than by directors. Inasmuch, as Mr. Walker has written to this end, we wish him success but wish much more that he had treated his subject as being as big and as broad as it really is. To a great extent successful works management is a combination of administrative and technical knowledge and good judgment. Any works manager who is deficient in any one of these is much handicapped. Management calls for a recognition of principles rather than a learning of details, and while it would be wrong to say the author has not dealt with principles yet, in some cases, they are so mixed up with details that the value of the book to the busy manager will be largely discounted.

THE PENANG HILLS RAILWAY.

ONE of the most important ports of the East, Penang, is the emporium for the northern and more prosperous parts of Sumatra and the Malay Peninsula. As will be generally known, Penang, or Prince of Wales's Island, is an island some 15 miles long and 12 miles broad, the chief town and capital, Georgetown, being situated on the eastern side, opposite the mainland. The Settlement includes a strip of country on the mainland known as Province Wellesley. Penang Island is formed by mountainous and broken country, and as it is situated not far from the Equator and the capital is at sea level the climate is somewhat trying for Europeans. In these circumstances it is not surprising that a settlement or hill suburb is growing up on Penang Hills, which lie behind the town. Owing to the steep and rocky nature of the country, however, access to the summit has, until quite recently, been possible only by a tiresome and difficult journey by hill track some 5 miles long, impossible for vehicles of any kind, the ascent taking some 1½ hours.

The advantage of rendering the summit of the hills more accessible has been obvious for many years, and some 25 years ago an attempt was made to construct a funicular railway to the summit. The railway was in fact actually built, but apparently those responsible for it had an insufficient appreciation of the difficulties of the task they had undertaken, or of the mechanical considerations which had to be complied with, and at the trial when the railway was ready to be opened to the public it was found that the cars could not be started. They, in fact, never were started, and not a single trip, nor part of a trip, was even made. The material of this early railway was left on the ground, and parts of it have proved of some service in the construction of the new line with which this article is concerned. This new railway was opened for public service on October 21 last year, and officially opened by His Excellency the Governor of the Straits Settlements, Sir Laurence Nunns Guillemard, K.C.B., K.C.M.G., on January 1 of this year, and has been in very successful operation ever since.

The first railway was constructed by a private company, but the present enterprise is a State one, being undertaken and carried through by the Federated Malay States Railways. The first survey for the work was carried out in 1909 and construction was started in 1914. The war interfered with progress, as with that of so many other public works, and all construction was stopped for 5 years. A re-start was made in 1920, and the work carried to completion in the autumn of last year. The work has throughout been under the control of Mr. A. R. Johnson, A.M.I.Mech.E., of the Federated Malay States Railways. The arrangement was probably a somewhat unusual one for a work of this magnitude, and Mr. Johnson not only carried out all the surveys and determined the location of the railway, but also designed and carried through the construction work and drafted the specifications for all the mechanical material. He acted as his own resident engineer throughout the whole of the work.

A plan of the railway is given in Fig. 1 opposite and its situation in relation to Georgetown, the capital of Penang Island, is illustrated in the map

given in Fig. 2. The lower station is 4 miles from the centre of the town, and is served by a good road and by the tramcar service. The railway has a total length of 1 mile 435 yards, and the upper station is situated 2,381 ft. above sea level. Profiles of the line are given in Figs. 3 and 4. The total time taken for the journey to the top is about 25 minutes. It is interesting to note that the configuration of the hill is such that an ordinary adhesion railway to the summit would have to be 25 miles long, and the journey would take about two hours. The conditions militating against an adhesion railway apply almost equally to a rack railway, and such a line would not only have involved a longer journey, measured in time, than does the funicular railway, but would have been very much more costly to construct. The physical features offered great difficulties in the construction of any line, as is well illustrated in Figs. 34 and 35 on page 678, which show parts of the route of the funicular railway, and any rack railway would have involved a great increase even on the heavy constructional work which has been necessary. The whole hill side is to a large extent covered with granite boulders, some of enormous size, one having a weight of some 12,000 tons.

In any funicular railway the haulage engine has to move not only the cars but also the haulage rope, which may be considerably heavier than the useful load. The load on the engine is variable, as the relative positions of the cars alter. The ideal arrangement is one in which the tractive force required from the haulage engine is a constant, and this effect is obtained by making the profile of the railway a parabola. It is not possible in practice to obtain an absolutely constant load on the haulage engine, since a variable is introduced owing to changes in the loading of the cars, which are a necessary feature of any railway, but a profile may be determined for the line which will demand an approximately constant output from the engine over a wide range of car loading. The Penang Hills Railway has been set out with such a parabolic profile, and one of the striking features of the line is not only the practically constant loading of the haulage engine, but also the remarkably small power which it demands for its operation. The railway, as shown in the plan, Fig. 1, is constructed in two sections with an interchange station in the middle. This arrangement was adopted as best meeting the very difficult conditions which had to be dealt with. It would have been possible to obtain a location with correct profile for a railway consisting of a single section, but the total cost of the line would have been considerably greater and the carrying capacity less. With two sections and cars of equal capacity,

Fig. 1. PENANG HILLS RAILWAY GENERAL PLAN.

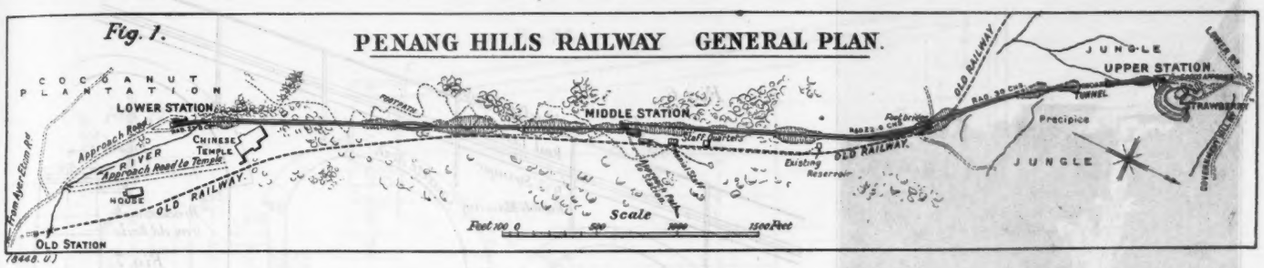


Fig. 2.

Fig. 3. LONGITUDINAL SECTION OF UPPER HALF.

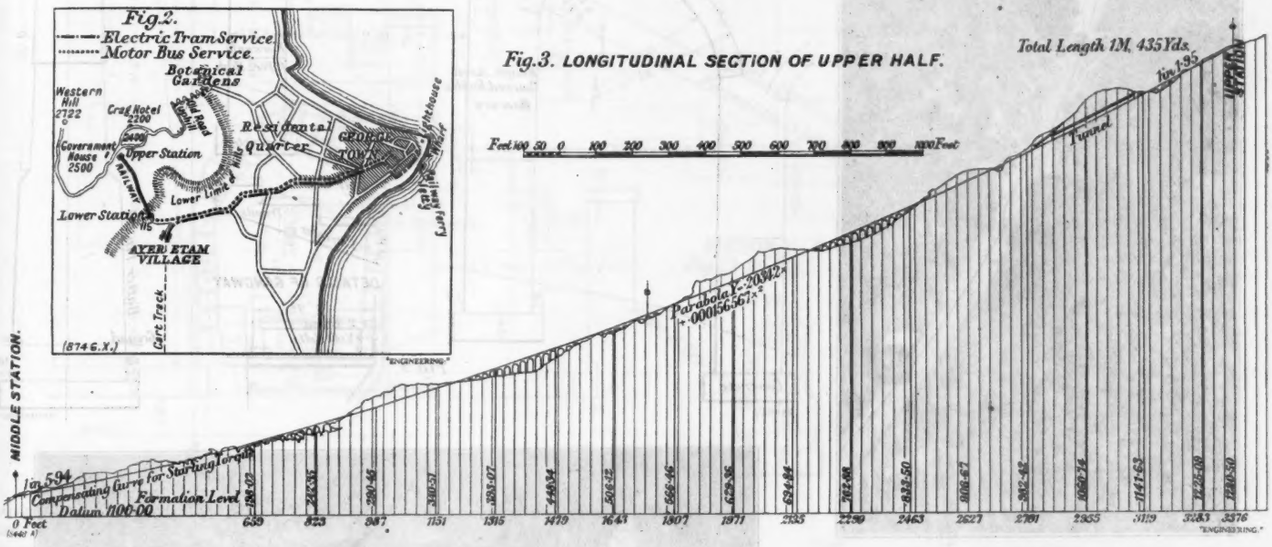
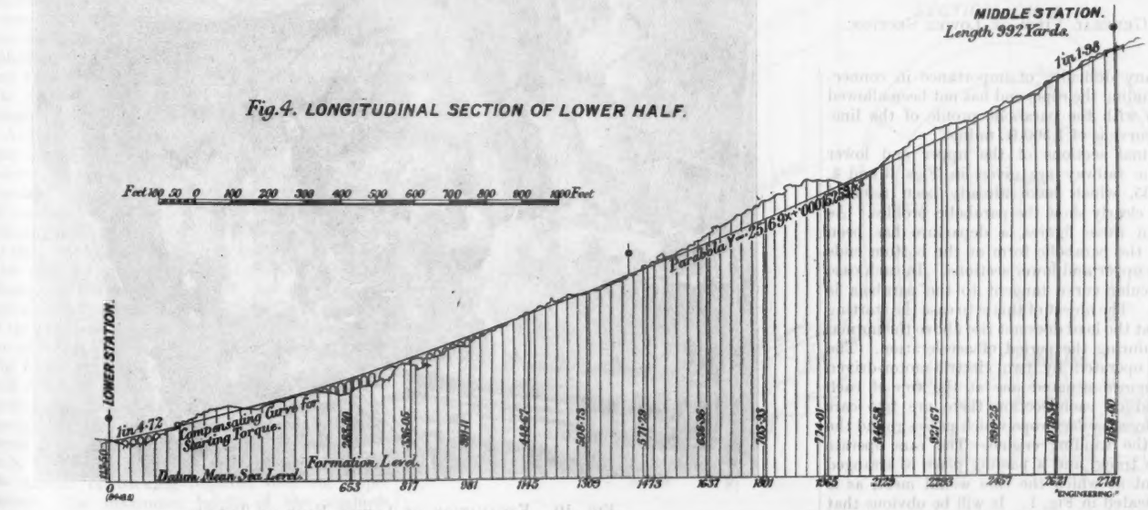


Fig. 4. LONGITUDINAL SECTION OF LOWER HALF.



double the number of passengers may at any moment be in process of transport on the line. It will be seen from Fig. 1 that a certain amount of horizontal curvature has been introduced in the line. This has been done entirely for structural reasons owing to the country traversed. It is insufficient to introduce any difficulty of importance in connection with guiding the rope, and has not been allowed to interfere with the parabolic profile of the line. The worst curve is of 1,500-ft. radius.

FIG. 5. GENERAL VIEW OF LOWER SECTION.

Longitudinal sections of the upper and lower parts of the railway are given in Figs. 3 and 4, on page 665, which have already been referred to. These clearly show the parabolic profiles. As indicated in these figures, a departure has been made from the parabolic form at the bottom ends of both the upper and lower sections. In each case a short circular curve tangent to the parabola is introduced. The object of this is to ease the starting grade so that the load does not rise above the normal maximum during the period of acceleration. The railway is operated by two electric-motor-driven winding engines situated one at the top of each section, and on each section there are two cars connected by a haulage rope which passes round the drums of the winding engine. The cars operate on a single track, and a passing place is arranged at the point at which the cars would meet, as is clearly indicated in Fig. 1. It will be obvious that when the cars are at this point the load on the winding engine due to the haulage rope is nil, since the descending portion will balance the ascending portion. In any other position of the cars, however, this load is not balanced, and while the ascending car is below the passing place, the pull due to the ascending rope will be greater than that due to the descending rope, and the difference has to be made up by the haulage gear. When, however, the ascending car has passed the middle of the section, the pull due to the descending rope is greater than that due to the ascending one, so that the weight of the rope actually assists the haulage engine. To maintain a constant tractive effort the steepness of the line is increased towards the upper end, so that the reduced effect of the rope is made up by an increased effect due to the ascending car. A mathematical investigation of the conditions shows that for constant tractive effort a parabolic profile is necessary, and, as has already been mentioned, such a profile has been adopted. A general view of the lower half of the line is given in Fig. 5, on this page. Owing to the situation of the line it is not possible to obtain a general view of the whole railway.

As already mentioned the total length of the line measured along the formation level is 1 mile 435 yards, and the total rise in this distance is 2,270 ft. The mean gradient is slightly steeper than 1 in 3, and the maximum 1·98 on the lower section and 1·93 on the upper. The upper station is 2,381 ft. above sea level. As will be clear from Figs. 3 and 4, the upper section is longer than the lower, and as the cars on the two sections have to work in unison, a higher speed is adopted on the upper one. This is 5·25 ft. per second (3·58 miles an hour), while it is 4·28 ft. per second (2·9 miles an hour) for the lower. The acceleration is one-tenth of the full speed, or 0·525 and 0·428 ft. per second per second.

The very broken nature of the country over which the railway has been built is indicated in Figs. 3 and 4, from which it will be seen that the construction consists of viaducts alternating with

Fig. 6.

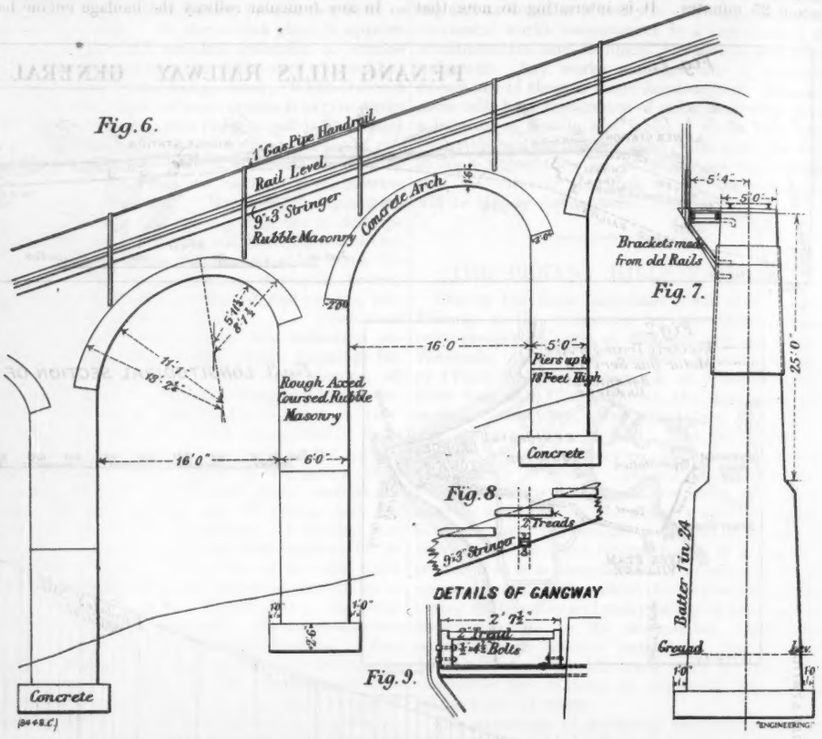


FIG. 10. EXCAVATION OF LOWER FACE OF TUNNEL.

cuttings, and that there is a tunnel 258 ft. long, which is one of the steepest in the world, near the summit of the upper section. There is a total length of viaducts of nearly half a mile, the longest being 775 ft. long and 50 ft. high at its highest point. There are 12 cuttings, the deepest being 68 ft. below the original ground level. In view of the tropical climate and the torrential rains which are experienced, and which would probably carry away any earth filling which might be attempted, especially on the very steep slopes which are an essential feature of the railway, the whole construction is in masonry throughout, and no loose stone ballast is used. The track is built into the masonry and anchored by long bolts at suitable intervals. The bottoms of all cuttings are pitched in step formation throughout.

As there was plenty of granite available on the spot, all viaducts are built in granite rubble with concrete arches, a 16-ft. arch being adopted as the standard and used throughout except in the case of two arches near the bottom of the lower section, where some very large boulders had to be crossed. At this place two 40-ft. arches have been introduced. The standard arches, the distribution of which throughout the railway can be seen from Figs. 3 and 4, are illustrated in Figs. 6 and 7, while details of the gangway which is carried alongside the track are given in Figs. 8 and 9. It will be seen from Fig. 6 that the arches are struck from two centres with different radii inside and out. The form thus produced gives a better resultant thrust, under the special conditions of gradient and unevenly distributed dead load, than any form of symmetrical arch. It also resulted in considerable saving in the amount of backing required over the upper haunch. The maximum height of the viaducts is 50 ft. from the top of the footings. As will be seen from Fig. 7, the viaducts are 5 ft. wide at the top. Some of the arches in various stages of construction are shown in the views given in Figs. 13 to 22, on Plates LXIX, LXX and LXXI, and in Figs. 36 and 37 on page 678.

It will be realised that the constructional conditions of the railway were very difficult. All cement sand and other material, except stone, had to be transported up to the work over very rugged country, while it was, in general, impossible to find any even approximately level area on which any sort of yard or erection shops could be provided. The method actually employed was to divide the hill into six separate hauls for the transport of materials. The lowest of these hauls was worked by the old haulage engine which had been installed for the operation of the original railway, but which proved incapable even of starting the cars. This engine was operated by a Pelton wheel, and after being put in proper repair and a proper lead for the haulage rope had been arranged, proved quite successful and satisfactory. The engine transported some forty thousand loads of materials during the construction. The four centre working hauls were provided with temporary tracks and were operated by steam winches, while the upper one consisted of an aerial ropeway some 600 ft. long worked by a steam winch and capable of carrying loads up to half a ton. In the later stages of construction the temporary tracks were abandoned and the materials were hauled up the new line. Some of the engine parts which had to be dealt with in this way had a weight of more than four tons.

The general method of construction will be followed from the various views given in Figs. 15 to 18. There was little trouble in finding a satisfactory foundation for the piers, and in several cases they were built directly on large boulders, or the boulders were incorporated in the structure. Interesting examples of this kind are shown in Figs. 13 and 14 and 19 to 21. As will be seen from the figures the masonry piers were constructed with scaffolding, and the concrete arches were run over wooden forms in the usual way, the masonry backing them being then completed. Apart from the upper section, on which the overhead runway was installed, and two overhead cableways which were used between Marks 817 and 1145 on the lower section, and Marks 659 and 823 on the upper section, cement and stone were transported from the temporary track to the building-in position

Fig. 27.

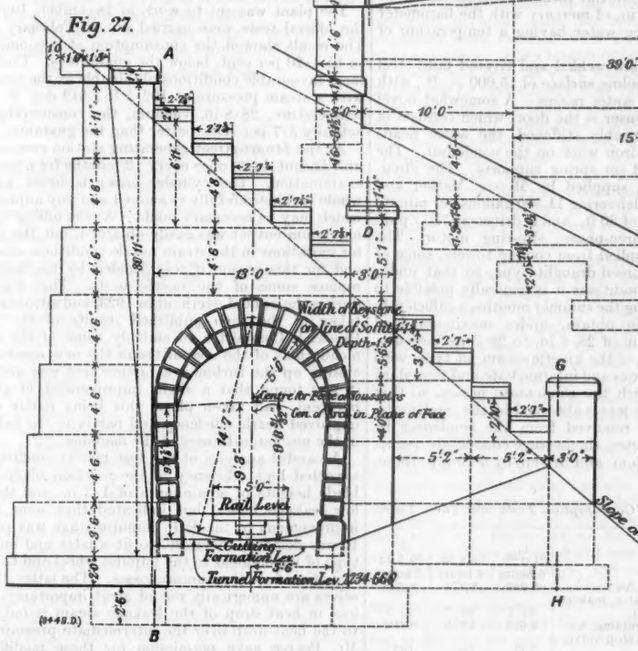


Fig. 28.

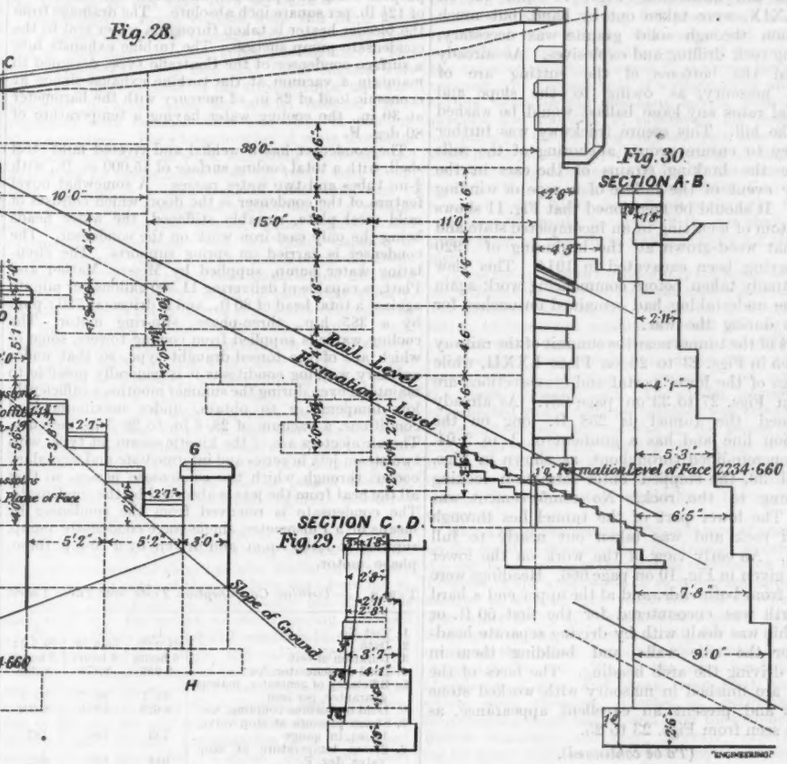


Fig. 29.

Fig. 30.

Fig. 31.

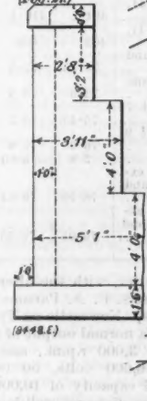


Fig. 32.

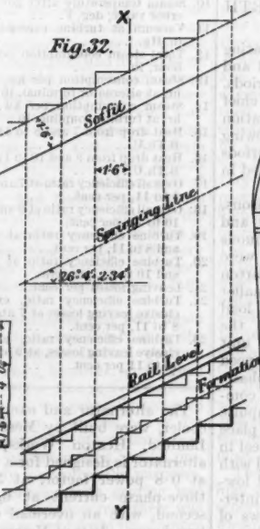
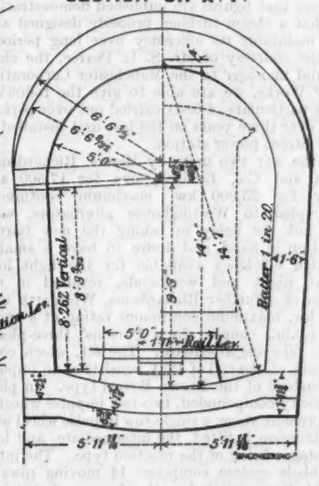


Fig. 33.



by hand, labour being cheap and plentiful. Chinese and Indian coolies were mostly employed, with one English tunnel foreman, one English chief inspector, and native foremen. In many cases the existence of a cutting enabled material to be taken up a temporary track to the level at which it had to be used. The cuttings of which two examples are illustrated, Figs. 11 and 12, on Plate LXIX, were taken out by hand, but much excavation through solid granite was necessary, involving rock drilling and explosives. As already indicated the bottoms of the cutting are of built-in masonry, as owing to the slope and torrential rains any loose ballast would be washed down the hill. This secure trackway was further necessary to ensure proper anchoring of the rails to take the braking strains of the cars in the unlikely event of the failure of a rope or winding engine. It should be mentioned that Fig. 11 shows the bottom of a cutting in an incompleted state and somewhat weed-grown at the beginning of 1920 after having been excavated in 1914. This view was actually taken before commencing work again after the undertaking had remained untouched for 5 years during the war.

Views of the tunnel near the summit of the railway are given in Figs. 23 to 26 on Plate LXXII, while drawings of the lower portal and cross-sections are given in Figs. 27 to 33 on page 667. As already mentioned the tunnel is 258 ft. long on the formation line and has a gradient of 1 in 2·04. It is concrete-lined throughout, as shown in Figs. 32 and 33, the stepped outer formation locking the lining to the rock. No reinforcement was used. The lower part of the tunnel lies through fissured rock and was taken out nearly to full section. An early view of the work on the lower face is given in Fig. 10 on page 666. Headings were driven from both ends, and at the upper end a hard red earth was encountered for the first 50 ft. or so. This was dealt with by driving separate headings for the side walls and building them in before driving the arch heading. The faces of the tunnel are finished in masonry with worked stone facings and present an excellent appearance, as will be seen from Figs. 23 to 25.

(To be continued).

TESTS ON A RICHARDSONS, WESTGARTH AND CO.'S STEAM TURBINE.

It is rarely that figures are published demonstrating the fact that a steam turbine, properly designed and operated, maintains its efficiency over long periods. Through the courtesy of Mr. S. L. Pearce, the chief engineer and manager to the Manchester Corporation Electricity Works, we are able to give the following interesting particulars of tests carried out over periods extending over three years on the last unit installed in the Stuart Street power station.

During the war two units by Messrs. Richardsons, Westgarth and Co., Limited, one for 17,500 and the other for 25,000 kw. maximum continuous rating, coupled to Westinghouse alternators, were installed, but the delay in taking the new Barton power station in hand, and desire to have a smaller unit of high efficiency available for the light load periods at night and week-ends, resulted in the installation of a further Richardsons, Westgarth unit of 10,000 kw. maximum continuous rating at a speed of 3,000 r.p.m., coupled to a Parsons' three-phase, 6,600-volt, 50-cycle alternator. The set, which commenced work at the end of 1921, consists of an impulse reaction turbine of the Brown Boveri type. In place of the velocity-compounded, two-row impulse wheel in the high-pressure stage, a single-row impulse wheel with partial admission is fitted, the intermediate- and low-pressure stages being of the reaction type. The intermediate blade system comprises 14 moving rows of reaction blading, mounted on the drum, and these are followed by 6 wheels, each carrying a single row of reaction blading. Attention may be drawn to the construction of the turbine rotor, which is built up of a solid rotor spindle, carrying at one end the dummy and high-pressure disc, and at the other end the six discs supporting the low-pressure blading. With rotors for 3,000 r.p.m., where the highest grade material and uniform quality are essential, this design has the decided advantage of consisting of plain forgings of relatively small dimension, presenting no great difficulties in forging or heat treatment. At the same time the design of the rotor is such that the first critical speed is at least 30 per cent. above the running speed.

The turbine is designed for a steam pressure of 200 lb. per square inch gauge, a steam temperature of 650 deg. F. and vacuum at the turbine exhaust flange of 28 in. at 30 in. Hg. barometer. The economic output was fixed at approximately 8,000 kw., the maximum output being 10,000 kw. at 3,000 r.p.m. From the low-pressure stage, steam is bled for raising the temperature of the condensate by means of a surface heater to 185 deg., the steam used for the purpose being at a pressure, under full load conditions, of 12½ lb. per square inch absolute. The drainage from the bleeder heater is taken through a water seal to the condensate pump suction. The turbine exhausts into a surface condenser of the Contraflo type, designed to maintain a vacuum at the turbine exhaust flange at economic load of 28 in. of mercury with the barometer at 30 in., the cooling water having a temperature of 80 deg. F.

The condenser has a welded and riveted mild steel shell, with a total cooling surface of 15,000 sq. ft., with ¾-in. tubes and two water passes. A somewhat novel feature of the condenser is the door, which consists of mild steel plate, suitably stiffened, the water heads being the only cast-iron work on the condenser. The condenser is carried on spring supports. The circulating water pump, supplied by Messrs. Mather and Platt, is capable of delivering 11,500 gallons per minute against a total head of 80 ft., and is driven at 720 r.p.m. by a 385 h.p., three-phase, slip-ring motor. The cooling water is supplied from cooling towers, some of which are of the forced-draught type, so that under ordinary working conditions it is generally possible to maintain, even during the summer months, a sufficiently low temperature to obtain, under maximum load conditions, a vacuum of 28·4 in. to 28·5 in. mercury. The air ejectors are of the kinetic steam jet type, with two steam jets in series and intermediate and secondary cooler, through which the condensate passes, so that all the heat from the jets is absorbed by the condensate. The condensate is removed from the condenser by means of a Pulsometer, single-stage condensate pump, running at 1,465 r.p.m. and driven by a 20-h.p. three-phase motor.

Table I.—*Turbine Consumption Tests over Three Years.*

	1.	2.	3.
1. Test No.			
2. Date	21.3.22.	15.3.23.	29.5.24
3. Duration of test	6 hours	6 hours	3 hours.
4. Load on generator, kw.	8,254	8,476	8,228
5. Efficiency of generator, makers' guarantee, per cent.	95·7	95·75	95·7
6. Load on turbine coupling, kw.	8,625	8,850	8,600
7. Steam pressure at stop valve, lb./sq. in. gauge	193	194	197
8. Steam temperature at stop valve, deg. F.	644	634	632
9. Steam pressure after governor valve, lb./sq. in. gauge	183	186	182
10. Steam temperature after governor valve, deg. F.	644	634	632
11. Vacuum at turbine exhaust, in. Hg.	28·16	28·4	28·46
12. Total steam consumption per hour, lb.	95,415	96,855	92,974
13. Steam consumption per kw.-hr. at alternator terminal, lb.	11·56	11·43	11·3
14. Steam consumption per kw.-hr. at turbine coupling, lb.	11·06	10·945	10·8
15. Heat drop from 7 and 8 to 11, B.Th.U.	404·2	410·4	410
16. Heat drop from 9 and 10 to 11, B.Th.U.	402	408	407·7
17. Overall efficiency ratio at 7 and 8 to 11, per cent.	73·15	72·9	73·8
18. Overall efficiency ratio at 9 and 10 to 11, per cent.	73·6	73·3	74·25
19. Turbine efficiency ratio at 7 and 8 to 11, per cent.	76·45	76·2	77·2
20. Turbine efficiency ratio at 9 and 10 to 11, per cent.	76·9	76·6	77·7
21. Leaving losses per cent.	2·8	3·86	3·66
22. Turbine efficiency ratio, exclusive leaving losses at 7 and 8 to 11, per cent.	78·59	79·14	80·2
23. Turbine efficiency ratio, exclusive leaving losses, at 9 and 10 to 11 per cent.	79·05	79·56	80·7

The alternator and exciter, with the alternator air cooler, were built by Messrs. C. A. Parsons and Co., Limited, Heaton Works, Newcastle-on-Tyne. The alternator is designed for a normal output of 8,000 kw. at 0·8 power factor, at 3,000 r.p.m., and supplies three-phase current at 6,600 volts, 50 cycles per second, with an overload capacity of 10,000 kw. for two hours. It is of Messrs. Parsons' well-known standard construction, the stator windings being strongly clamped and braced to withstand the stresses due to sudden short circuits occurring under operating conditions. The rotor is machined from a solid forging and the windings, which are carried in radial slots milled in the periphery, are insulated throughout with mica. The exciter is a four-pole machine of the compound interpole type and is directly coupled to the alternator shaft through a solid coupling.

Messrs. C. A. Parsons and Co.'s patent combined axial and radial ventilation is adopted for cooling the alternator. In this arrangement the cooling air enters and leaves the alternator throughout its complete length, ensuring that all parts are uniformly cooled. A novel feature of the ventilation scheme is, further, the fact that the same air is re-circulated through the alternator, after passing through a surface cooler. The hot air passes from the alternator to the cooler and from thence to the fan, which delivers it back to the alternator inlet, thus forming a "closed circuit" system. The external fan is directly coupled to a three-phase motor and deals with 36,000 cub. ft. of air per minute. The alternator air cooler is of Messrs. C. A. Parsons and Co.'s standard construction and is accommodated in the foundation block, giving a very compact arrangement, eliminating the long lengths of external air ducts which have hitherto been necessary with the use of air filters.

The plant was set to work in December, 1921, and the official tests were carried out in February, 1922. The result showed the consumption at economic load to be 1·20 per cent. below the guarantees. Under the most favourable conditions obtainable at the time, i.e., with a steam pressure at 192·5 lb., 642 deg. F. steam temperature, 28·8-in. vacuum, the consumption was actually 3·7 per cent. better than the guarantee.

At the Stuart-street generating station each turbine unit is shut down once every 12 months for a thorough examination. The cylinder cover is lifted and the whole turbine carefully examined and any adjustments which may be necessary made. At the official test the maximum output was easily obtained, but the margin for variations in the steam nozzle conditions was small, and for this reason it was decided by the makers to replace some of the nozzle units. This was done during the annual overhaul in 1923, and advantage was taken of the then published results of the Nozzle Research Committee to embody some of the recommendations of the committee in the new nozzles. On closing up the turbines, a further test was made and it was found that a slight improvement of about ½ per cent. had taken place, this being partly due to improved nozzle efficiency and partly to the reduction in the mechanical losses of the machine.

A careful analysis of the test results confirmed the expected high efficiency of the reaction blading with blade heights of a minimum of 1·3 in. and therefore low leakage losses, but indicated that some further improvement to the H.P. impulse stage was possible. It was decided, therefore, to fit a later and improved type of wind shield to the impulse wheel and to endeavour to reduce the dummy losses. The latter in themselves are numerically not of great importance, as the loss in heat drop of the leakage steam is only equal to the heat drop over the intermediate pressure stage. Mr. Pearce gave permission for these modifications to be made during the annual overhaul this spring. On this occasion a very careful examination was made of the blading for signs of erosion or corrosion, and it was found that the blading, glands and dummy strips were all in perfect condition. The result of the modification was a further improvement in the consumption.

Table I gives the test figures of the Testing Department of the Manchester Corporation Electricity Works on the three tests, as follows:—

(1) Official taking over tests.

(2) Tests after first annual overhaul after alteration to nozzles.

(3) Tests after second annual overhaul after fitting new wind screen and readjustment of dummy clearance.

The figures given are the actual test figures uncorrected to the guarentee condition and as the exhaust conditions varied under all three tests, the leaving losses have been calculated to arrive at the turbine efficiency ratio exclusive of leaving losses, to give a measure of the improvement obtained.

Table II shows the actual improvement obtained on the guarantee, when the test figures are corrected to the guarantee conditions.

Table II.—*Turbine Consumption Tests Relative to Guarantee Figures.*

	1.	2.	3.
1. Test No.			
2. Date	21.3.22	15.3.23	29.5.24
3. Duration of test	6 hours	6 hours	3 hours.
4. Load on alternator, kw.	8,254	8,476	8,228
5. Steam pressure at stop valve, lb./sq. in. gauge	193	194	197
6. Steam temperature at stop valve, deg. F.	645	634	632
7. Vacuum at turbine exhaust in. Hg.	28·16	28·4	28·46
8. Total steam consumption, lb. per hr.	95,416	96,855	92,974
9. Steam consumption, lb. per kw. hr. at alternator coupling	11·56	11·43	11·3
10. Steam consumption per kw.-hr. as 9 corrected to guarantee conditions, 200 lb. 650 deg. F. 28 in. vac.	11·56	11·48	11·38
11. Steam consumption, lb. per kw.-hr. guaranteed	11·70	11·70	11·70
12. Improvement above guarantees, per cent.	1·20	1·88	2·73

A comparison between the consumptions at partial loads may be of interest. The test figures obtained

are as follows, in this case all corrected to standard conditions.

TABLE III.

Load.	Consumption.	Variation from Economical Consumption.
Kw.	lb./kw.-hr.	Per cent.
9,713	11·750	1·87
8,254	11·534	0
6,404	11·738	1·76
4,389	12·204	5·9

These figures demonstrate the advantage of the subdivision of the nozzles and the benefit of nozzle governing on the consumption at partial loads.

Table IV gives the condenser tests under the economical load and the maximum load conditions.

TABLE IV.—*Condenser Test.*

	1.	4.
1. Test No.		
2. Date	21.3.22.	24.3.22.
3. Duration	6 hours	2 hours
4. Loads, kw.	8,254	9,713
5. Steam condensed, lb. per hour	93,415	114,035
6. Load lb. per square foot surface	6·36	7·61
7. Circulating water inlet temperature, deg. F.	79·9	77·94
8. Circulating water outlet temperature, deg. F.	93·9	94·20
9. Circulating water temperature rise deg. F.	14·0	16·76
10. Quantity of circulating water, g.p.m.	10,887	10,968
11. Vacuum at inlet at 30 in. bar, in. Hg.	28·16	28·11
12. Steam temperature at inlet, deg. F.	96·8	98·1
13. Vacuum at air suction, in. Hg.	28·28	28·25
14. Temperature at air suction, deg. F.	95·3	96·0
15. Condensate temperature at bottom of condenser, deg. F.	96·5	97·0
16. Feed temperature, exclusive of bleeder, deg. F.	108·0	107·2
17. Heat transmission co-efficient B.Th.U./deg. F./sq. ft./hr.	703	840

Particular attention should be drawn to the very small drop through the condenser and the difference of only 1·4 deg. between the condensate temperature at the bottom of the condenser, and the steam temperature at the inlet to the condenser. It may be of interest to point out that the condenser had been in continuous operation for about two months and had not been specially cleaned prior to the test. The excellent results of the condenser tests are mainly due to the small amount of air leakage in the systems. So far as possible air leakage has been prevented by careful workmanship and attention to the joints and parts operating under vacuum, and no doubt exists that with proper care joints subject to a vacuum can be made air-tight.

THE DEVELOPMENT OF MARINE PROPELLING MACHINERY.

FOR the eleventh Thomas Hawksley lecture, which was delivered before the Institution of Mechanical Engineers on Friday last, Engineer Vice-Admiral Sir George G. Goodwin took for his subject, "The Trend of Development of Marine Propelling Machinery." In the absence of the President of the Institution, Mr. W. H. Patchell, the chair was taken by Sir Henry Fowler, Vice-President.

In opening his lecture Sir George Goodwin referred to the interest taken in naval and marine engineering matters by Thomas Hawksley, in memory of whom the annual lecture had been instituted. Sir George confined himself to the machinery side of the question, excluding the subject of steam generation. He first pointed out the influence on development of naval and mercantile marine machinery of limits of weight and space which were stringent in warship design, while the allowance in merchant shipping was on a more liberal scale so that the conditions to be met were quite different in the two cases, yet both tended to produce machinery of the maximum possible reliability and economy. Marine propelling machinery developed, in fact, without sacrifice of reliability, endurance and durability, (1) in warships by the striving for high power on low weight per horse-power, involving the development of high-class and special materials and by the concurrent aiming at the most economical running under very varying conditions, and (2) in merchant ships, where weight was allowed on a more generous scale, and where steady running at constant speed was the rule, by the efforts to reduce fuel consumption and, as far as other conditions would allow, by arranging the design to enable the machinery to be manufactured, but manufactured properly at low cost, and to be kept running efficiently with a low repair bill and other running costs.

Sir George Goodwin proceeded to quote the latest figures from Lloyd's Register annual report, showing the proportion of shipping fitted with different classes of propelling machinery, and, with the aid of a table showing similar figures for the past five years, indicated the general trend by means of percentage figures. For instance, the tonnage fitted with reciprocating steam engines, although still by far the largest class, had decreased from 70 per cent. of the total to 52·3 per cent. in the course of the past five years. The tonnage for the last four years, fitted with steam turbines, all of the all-geared type, had increased from 28 per cent. to 37·4 per cent. of the total. The tonnage fitted with internal combustion motors in the same period had increased from 2 per cent. of the total to no less than 10·3 per cent.

Reciprocating steam engines were still being built for a larger amount of tonnage than any other type, and in fact than all other types put together. This was explained by the fact that these engines were fitted to a large number of the smaller ships, and were preferred in other cases for special reasons. More engineers were familiar with this class of machine than any other. For a large number of years thousands of minds had been at work amending its details and improving its performance with the result that it had been brought to a high state of perfection, and it had a high and widespread reputation as a reliable and easily manipulated engine, acting regularly and extensively understood, and one easily capable of adjustment and repair. It was also a relatively cheap engine to build, and one whose manufacture had been so well organised that it could be built very quickly. In many cases it could be run sufficiently economically for the purposes of its owner. The engines were, however, rather being repeated than further developed. The larger units of this type were very long, and weight was cut very low, so that running at full power was attended by anxiety; 15,000 i.h.p. per shaft was about the limit with this class for slow-running engines, and 4,000 i.h.p. for the fast-running type. But turbine had enabled the horse-power per shaft to be raised to 38,000 through the use of reduction gears. The saving of fuel by the use of geared turbines, as compared with reciprocating engines, amounted to about 20 per cent.

The record for the large number of geared turbine sets in use in the Navy was a very satisfactory one. The earlier merchant ships had also similar satisfactory experience, but some of those of later date were not so fortunate. The cases of failure were not numerous compared with the extent to which gearing had been adopted, but they occurred with considerable frequency over a short range of time, and caused great inconvenience. This difference in behaviour led to a searching comparison in which all interested assisted. The comparison was in many respects useful and suggestive, but it did not, at any rate immediately, provide the remedy, and further investigation and piece-meal improvement proceeded. Various significant facts and features had been brought forward and discussed, but Sir George did not think general agreement had been reached. For practical purposes, that was not now important, because, while marine engineers and manufacturing engineers steadfastly proceeded to put their own house in order, metallurgists had left no stone unturned to improve the material, and the treatment of the material, for replace pinions and pinions of new designs, and to bring the material in its working condition into line with the general desire expressed during the long discussion. The results of these joint efforts had been, as far as he knew, satisfactory, and he had been informed on very good authority that no case of faulty or fractured gearing had been reported since April last. To realise the importance of this fact the large number of gears now on service should be kept in mind. It was to be hoped that this present satisfactory state of affairs would continue, and that the confidence of shipowners and others interested would soon be fully restored.

Electric and hydraulic transmission had been again brought forward recently with a view to avoiding the troubles experienced with double-reduction gearing. Their inherent disadvantages had, however, outweighed their known advantages, and these alternatives had not been adopted in this country. It was generally accepted here that electrical transmission was too heavy for naval purposes, having regard to other important fighting qualities that this excess weight would prejudice, while it was too costly for mercantile purposes.

His references to the experience with gearing was intended to show that when a check occurred there was a wealth of engineering science and ability in the country which could be brought to its rescue and would see the matter through in our own characteristic way; and that many engineers and scientists other than those directly interested in the development and main purposes, could lend a hand in the process.

Whether we were yet ready for the adoption of higher boiler pressures afloat was a little problematical. The conditions were different in many respects from those on shore, and experience of the past, especially in such matters as steam joints, &c., called for caution and investigation to ensure the requisite reliability under marine conditions. The problem was attractive and was receiving attention with a view to putting the turbine in a better position to compete successfully with the heavy oil engine in the numerous class of ships for which the latter is suitable. As regards superheating, conditions afloat did not lend themselves so readily to high superheat as those on shore, chiefly on account of the restrictions set by the limitations of weight and space. Marine superheaters were of the uptake or smoke-tube type and could be arranged to give 200 deg. F. or more. In merchant ships the full advantages of superheat could be maintained throughout each voyage. In warships the maximum superheat could be obtained during full power, but as only a fraction of the steaming was carried out under full power, and at other times the superheat was much less, the value of superheaters was in this case largely discounted. In a recent trial of a single-screw all-geared turbine vessel in the merchant service, with 165 lb. pressure and 200 deg. F. superheat, the steam consumption for the turbines only was just over 9 lb. per shaft horse-power-hour, while, including all auxiliaries, the latter using superheat at 90 deg. F., the consumption was 10·6 lb. Sir Charles Parsons stated that in such a vessel (with 3,000 shaft horse-power) the turbine consumption should be about 8 lb. per shaft horse-power-hour, so that there was still room for improvement.

It was not enough to consider only the better economical performance expected from the main ahead turbines. The problem included the examining of whether the astern turbines and auxiliaries could use high temperature steam with advantage and safety. When the main engines were running ahead the astern turbines were generally running in vacuum, and normally they were relatively cold. The sudden admission of superheated steam to these turbines was attended by some risk, unless the material of the astern turbine casing was suitable for resisting the change of temperature, or means were taken to reduce the temperature, or alternatively the turbine was kept permanently warm. Both these steps would be at the expense of economy.

After a short discussion of the influence of auxiliaries on the trend of development, Sir George proceeded to discuss the prospects of the internal combustion engine. Progress in the application of such engines afloat was assured as soon as they stood the test of reliability. The earlier heavy oil engines of large power had been developed on the Continent mostly for use on shore, owing to the limited supply in Continental countries of good boiler coal. We, on the other hand, had an abundance of good and cheap steam coal, and our efforts were, therefore, directed to perfecting the reciprocating steam engine, and later the turbine. The British Admiralty had been, however, experimenting for many years with heavy oil engines afloat, and indeed, he thought they really gave the start to the building in this country of heavy oil engines for marine purposes. A further impetus was given after the war by the high price of coal and the difficulties arising through strikes.

All the advantages of oil as a boiler fuel were realised also, while oil was used in an internal combustion engine, and it was, therefore, quite logical to retain them and endeavour to obtain the additional and substantial advantage of reduced fuel consumption by considering the adoption of heavy oil engines. It was strange that in matters of design radical changes very often did not embody the lessons of the immediate past. Not many years previously the last of the high-power steam reciprocating engines had shown the necessity of amply strong and stiff engine bearers. The lesson learnt then had not been carried forward to the case of the heavy oil engine where the conditions were even more trying. More than one unsuccessful installation in the earlier marine applications could be attributed to lack of stiffness of the engine bearers. During the last two or three years matters had very much improved in all respects, and credit for most of the advance in marine applications had, in fairness, to be given to British engineers. So intimately were we associated with matters relating to the sea that this was the place where, when development of propelling machinery became necessary, it would be evolved most quickly.

That the heavy oil engine had now attained to a high degree of reliability was shown by the daily reports of shipping movements of vessels so engined, working to schedule times, implying the necessity only of normal repairs in ports, and by the fact that owners now trusted such vessels to carry out long voyages with valuable cargoes, and could obtain satisfactory terms from insurance companies. The engine which pioneered this successful venture was the single-acting four-stroke cycle engine, but there were now many single-acting two-stroke cycle engines satisfactorily at work, and some of the installations of high aggregate power and high-power per shaft were of this type. Early experience with regard to manipulation and the handling of the earlier marine oil engines was far from what was desired, and this defect caused much uneasiness to owners, &c., and gave this type of engine a bad reputation from which it suffered

"DEAN" ELECTRIC CONTROL FOR VALVES AT CHESTER WATERWORKS.

CONSTRUCTED BY THE IGRANIC ELECTRIC COMPANY, LIMITED, ENGINEERS, LONDON.

(*For Description, see opposite Page.*)

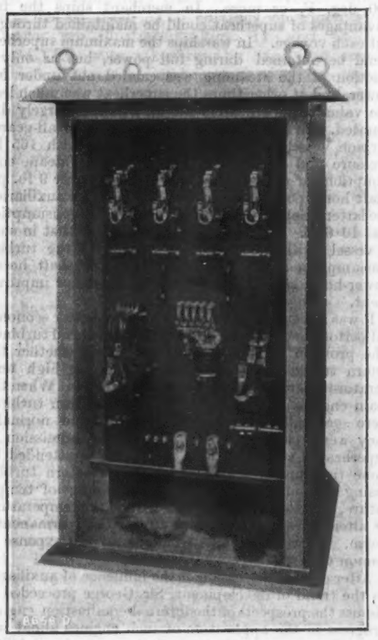
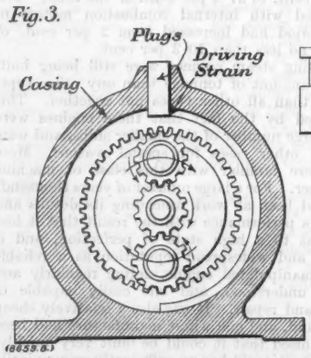
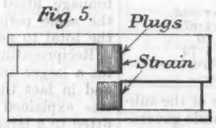
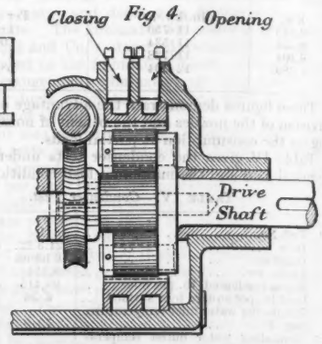


FIG. 1. AUTOMATIC MOTOR STARTING PANEL IN RIVERSIDE STATION.

FIG. 2. PUSH-BUTTON SWITCH IN TOWER WORKS.







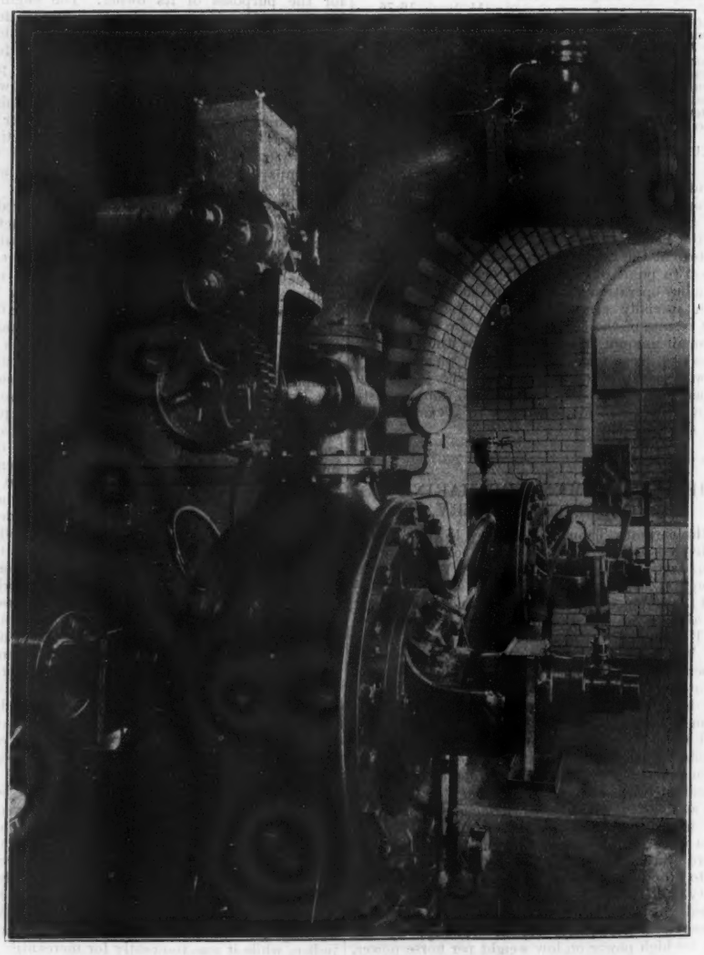


FIG. 6. TURBINE PUMPS WITH ELECTRICALLY-OPERATED AND CONTROLLED VALVES IN RIVERSIDE STATION.

for quite a long time. He believed the situation at the present time in this respect to be quite satisfactory, though mistrust still existed in certain quarters.

All heavy oil engines at the present time had an outstanding serious disadvantage—that of excess in weight. It was difficult to make exact comparisons, but the all-geared steam turbine machinery of a destroyer, including propellers and shafting, boilers, uptakes, funnels, &c., ran out at about 30 to 35 lb. per shaft horse-power, and for warship machinery at 70 to 80 lb. per shaft horse-power. The corresponding figure for the four-cycle type of oil engine was above 300 lb. per shaft horse power. It was contended that the weight of machinery plus fuel should be taken as the criterion. This was a valid argument when used in defence of the oil engine's inferiority in weight, but it begged the question from the real engineering progress point of view. Weight, very roughly, corresponded with manufacturing costs. An economical comparison of first cost, cost of fuel, wages of running staff, upkeep and repairs, had sometimes resulted in favour of steam engines.

Manufacturing costs would fall as the staff and men became more accustomed to the manufacture of these engines, but the difference in the way a steam engine and a heavy oil engine were tackled in a long-established shop was very noticeable. For the former the position was almost instinctively visualised for weeks ahead. Everyone knew precisely what was required and where everything was to be found; appliances were all ready and everything fell into its proper ordered sequence without blunder or delay. Things did not move with this smoothness in the case of the newer engines, and delays had a pernicious effect upon costs. This, of course, would be put right in time.

With the larger reduction in weight possible with the two-cycle type of engine it was probable that in a short time no further single-acting four-stroke engines would be manufactured for the ordinary types of ships in the Merchant Service. The next step would be the two-stroke double-acting engine. Difficulties were to be expected but would have to be overcome, as this must ultimately be the form in which the reciprocating heavy oil engine would be used. All reciprocating engines tended to develop in this way. Some of the difficulties had already been overcome, and in one case experience with engines of this type of British design and manufacture had already led to repeat orders. The type would permit of further reduction in weight per h.p. and corresponding reduction in cost. For large powers the four-stroke cycle engine involved an impossible multiplication of cylinders, but with the

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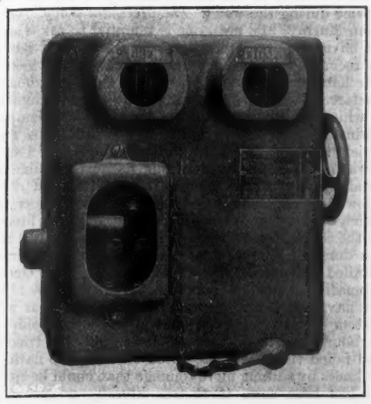


FIG. 7. DEAN VALVE CONTROL GEAR.

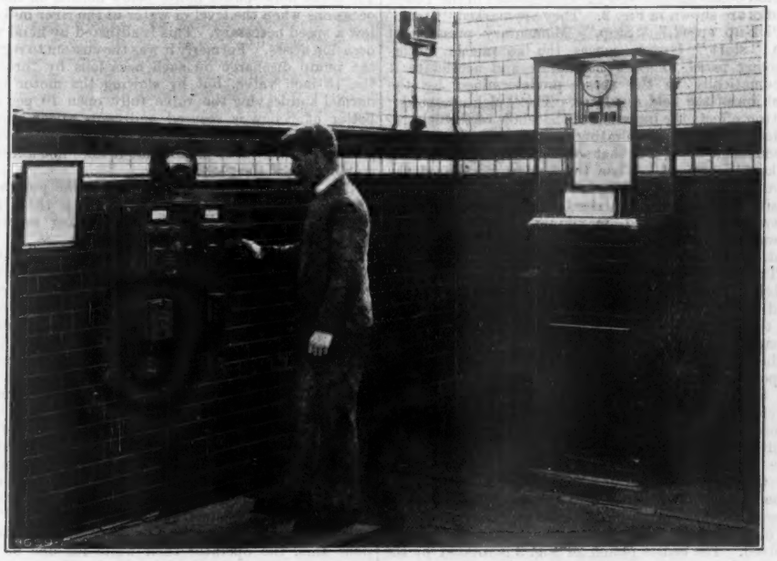


FIG. 8. CONTROL SWITCHBOARD IN THE TOWER WORKS.

two-stroke single-acting engine, for moderately high powers the cylinder arrangement became much more practicable. Moderate power was not sufficient for surface fighting ships, destroyers or the largest and fastest vessels of the merchant marine, and for these no grouping of cylinders could be arranged of practical value. There was no reason to suppose that the requirements of such vessels would be adequately met by internal combustion engines of the reciprocating type.

As regards further development it was a question whether attention in manufacturing works should be diverted to research investigations instead of being concentrated on production. He thought it probable that if fundamental research were necessary it would probably be better carried out elsewhere if proper touch could be kept with the factory. Individual research workers, however, were apt not to see the whole field and co-ordination with the engineer was necessary.

ELECTRICALLY-CONTROLLED PUMPING STATION.

THE waterworks of the City of Chester, which are the property of the Chester Waterworks Company, consist of a river intake situated above the city on the river Dee, a riverside pumping station ¾-mile away, and upon elevated ground a further ½-mile away works known as the Tower Works, comprising reservoirs, filters, a high level tank surmounting a brick and masonry water tower, and a power house containing Diesel engines and generators, electrically-driven turbo-pumps, &c. From the intake the water is piped and flows by gravity to the riverside station, whence it is pumped to the Tower Works. At the Tower Works, after treatment by sedimentation and double filtration, the water is collected in underground filtered water storage reservoirs and then pumped to the Tower tank, which is of sufficient elevation to allow the supply to gravitate to all parts of the company's area. In the power house near the base of the water tower all the necessary current is generated for operating the turbo-pumps at both the Tower Works and the riverside station, and for working air compressors in connection with rapid filters, lighting plant, &c.

The original installation in the riverside station consisted of steam-driven double-acting lift and force pumps, which were later superseded by electrically-driven turbine pumps with hand-operated starters. Great economy was effected by the change from steam-driven pumps to electrically-driven turbine pumps, but Mr. C. W. Bennett, the engineer of the Chester Waterworks, felt that still further economy might be achieved by arranging for all the pumping plant in the riverside station to be controlled from the Tower Works, thereby obviating the necessity for anybody to be in constant attendance at the Riverside Station. The provision of automatic starters for the motors presented no difficulty. The chief obstacle was to find a reliable method of operating the pump delivery valves electro-mechanically.

The difficulties encountered in attempting to open and close large valves by means of electric power are considerable, but the Dean system of control, which is manufactured by Igranic Electric Company Limited, satisfactorily meets the conditions. It is obviously important, when closing a valve, to ensure that it is brought positively on to its seat without jamming. This is very difficult to accomplish with certainty and uniformity at every time of operation, because it demands that the driving power be continued until the valve is actually seated and then instantaneously relieved. This instantaneous withdrawal of the driving power is the real difficulty, because even if the motor circuit be opened at the instant of seating, the inertia of the armature prevents instantaneous stoppage, with the result that the valve is jammed on its seat. If the motor circuit be opened just before the valve has actually seated and the drift of the armature be relied upon to complete the closing, uniformity of result is found to be impossible of attainment. Sometimes the valve will close, sometimes it will jam and sometimes it will stop just short of closure. A little unusual stiffness of the bearings, or a little grit in the valve is quite sufficient to upset the most careful adjustment. When opening the valve a quite different, but equally troublesome problem has to be faced. The torque required to start a valve moving, especially if it has been closed for some time, is much greater than is required to complete the operation of opening after the initial movement has been accomplished. If the power installed is only sufficient for the latter part of the operation, the motor is almost certain to be stalled if called upon, at the moment of starting, to exert the torque necessary to unseat the valve. If, on the other hand, a motor be employed of sufficient power to start against this abnormal torque, it generally races at great speed as soon as the valve is unseated, and very frequently valve stems have been twisted off from this cause.

In 1922 the Igranic Electric Company, Limited, of 147, Queen Victoria-street, London, submitted to Mr. Bennett details of the Dean system of electric control for valves. This afforded a complete solution of the difficulties. Its mechanism is so arranged as to ensure that, in closing, the valve is always positively driven actually on to its seat and at the very instant of seating the driving power is relieved, although the motor is free to coast, open circuited, until the inertia of its armature had been dissipated. This ensures positive closing without any danger of jamming. When opening the valve, the mechanism permits the motor to be accelerated to normal speed before coupling to the valve, with the result that, on being engaged, a hammer blow is imparted to the valve which is immediately unseated. Although the Dean control appeared to be satisfactory, there were at that time no installations available in this country for demonstrating its operation. However, after investigation and enquiry concerning the many Dean installations which had long worked satisfactorily in the U.S.A., Mr. Bennett became confident that this control would fulfil the requirements, and the approval of Mr. Frederick Storr, the consulting engineer to the Company, was obtained.

As the capital outlay was not excessive, the only point to settle before definitely placing the order for the complete equipment was the reliability of the valve control system. One of these controls was installed in January, 1923, and after a trial of six months without a failure, the order was placed for the first automatic motor-starting panel. This was for controlling the motor driving one of the turbine pumps, thereby making it possible to control one valve and one motor either from the riverside pumping station or the Tower Works. The first complete equipment was given a trial of five months, and as it operated during this time without a hitch of any kind, the order for the second equipment was placed, and the installation completed in March, 1924. From the dates given above it will be seen that the first Dean control has been in daily operation for over a year without a failure.

The riverside station has a direct-current supply at 420 volts pressure. One pump is controlled by a 12-in. valve and driven by a 115-h.p. motor, which has a normal speed of 950 r.p.m. and a maximum speed by field regulation of 1,150 r.p.m. The 12-in. valve requires 28 revolutions to open or close completely, and 56 revolutions on the Dean control, the ratio being 2 : 1. The other pump is controlled by a 15-in. valve and driven by a 130-h.p. motor, which has a normal speed of 930 r.p.m. and a maximum speed by field regulation of 1,100 r.p.m. The 15-in. valve requires 33 revolutions, or 66 revolutions on the Dean control. The time taken for opening and closing either valve is 50 to 60 seconds. This speed can be varied to suit other local conditions, if necessary, in other installations. In the course of priming the pumps any air which may have accumulated during a stand, escapes automatically through air valves of large dimensions which have been fitted at the highest part of each pump. Each pump delivers 100,000 gallons to 150,000 gallons per hour, dependent on the speed of the pump. The speed is determined by the setting of a field regulator in the riverside station, and may require to be varied two or three times per week. The lift is about 12 ft. to 20 ft., according to the level of the water in the river, and the head against the pumps to the Tower Works is 90 ft.

The Igranic equipment comprises two automatic motor-starting sets and two Dean valve-control sets. Each motor-starting set consists of an automatic motor-starting panel installed in the riverside station, and a three-way push-button box installed on a switchboard in the Tower Works to control the motor-starting panel. Fig. 1, on page 670, shows one of the automatic motor-starting panels. It will be observed that it is enclosed in a sheet-steel housing which stands on the floor. The panel consists of an iron framework carrying a slate, on which are mounted the contactor switches for cutting out the motor-starting resistance under the control of an adjustable time element relay. On the same panel is fitted one shunt regulator, with external brass handwheel and indicator plate. This field regulator is interlocked so that the motor always starts

with full field strength and automatically accelerates to the speed predetermined by the adjustment of the field regulator, the speed controlling resistance being gradually and automatically introduced into the field circuit by a vibrating relay. The three-way push button boxes mounted on the switchboard in the Tower Works are shown in Fig. 2. They are marked "Start," "Pick-up speed," "Stop." Momentary pressure of the "start" button causes the automatic motor-starting panel to start the motor and accelerate it automatically to the speed predetermined by the position of the field regulator. The "pick-up speed" button effects the insertion of the whole of the field resistance, thereby accelerating the motor to maximum speed and keeping it at that speed so long as this button is kept depressed. When the button is released the motor drops back to a speed corresponding with the position of the field regulator, which may be anything between normal and maximum pumping speeds. Pressure of the "stop" button brings the motor to rest.

The Dean valve control sets comprise the driving mechanism, installed in the riverside station, and the control gear, mounted on the switchboard in the Tower Works. Each driving mechanism is a complete ironclad unit, consisting of a motor-driven reduction gear of the combination worm and planetary type, to reduce the speed suitably for gearing directly to the valve stem. The principal features of the device from an operating standpoint are the instantaneous stop obtained, the elimination of over-travel or drift as affecting the closed position of the valve, and the hammer-blow available for unseating the valve at the commencement of the operation of opening. The quick stop and the elimination of the effects of inertia are obtained by means of the gear shown in Figs. 3 to 5, which show diagrammatically the mechanism involved. The centre pinion in Fig. 3 is rotated by the motor through a worm and worm wheel which are shown in Fig. 4. This turns the planetary pinions and valve-driving shaft in the direction shown. The internal gear is free to revolve on a machined surface in the casing, but is restrained from doing so by two plugs which pass through the casing. The outside surface of the internal gear is provided with two peripheral channels, one extending halfway round on one side, and another halfway round upon the opposite side, as shown in Fig. 5. When both plugs are seated in the channels the internal gear is locked so that with the centre pinion driven by the motor the planetary pinions must travel around their own axis and round the internal gear. This is the running arrangement of the mechanism. At the limit of travel the motor circuit is opened and the restraining plug removed at the same instant, so that the internal gear then rotates and takes up the drift of the motor without any longer driving the valve.

Assume that the valve is closing and the plug is restraining the movement of the internal gear. At the instant the valve is tightly closed, but not jammed, the motor is disconnected from the electric supply and the closing plug quickly withdrawn from the slot. This allows the internal gear to revolve and absorb the inertia of the driving mechanism. Thus the drift of the motor is provided for. The opening plug in the other channel provides the hammer-blow for unseating the valve. The lost motion mechanism is so designed that after closing the valve the motor comes to rest before the internal gear has travelled one-half of a complete revolution. The opening plug does not interfere with this motion but moves along in its channel. To open the valve the motor is reversed and the internal gear moves nearly one-half a revolution before it is restrained by the opening plug. By this means sufficient time is allowed for accelerating the motor before it has to begin to drive the valve, thus providing the blow often necessary to open a tightly-seated valve. The actual gear as installed is shown in Fig. 6.

The Dean valve control gear is illustrated in Fig. 7, on page 671, and is provided with bull's-eye indicator lamps. When the valve is completely closed the green signal bull's-eye lights up, and when the valve is completely open the red signal bull's-eye lights up. If the valve is in an intermediate position both signal lamps are alight. The station may be locked to prevent unauthorised persons tampering with the valves, but in a case of emergency the glass may be broken and the valve operated. The emergency switch with hammer may be seen in Fig. 7. The control switchboard in the Tower Works, on which are mounted the two Dean control gears and the two push-button boxes, is illustrated by Fig. 8.

In the riverside station, in addition to the two automatic motor starting panels and the two Dean valve-driving mechanisms, there is a control panel mounted with control gear like the sets in the Tower Works; and two similar 3-way push button boxes as well as two 5-way interlocked change-over switches to transfer the control of either valve from the Tower Works to the Dean control gear in the riverside station when desired. This control panel is to provide for operation of the pumps and valves at the riverside station when necessary. There is also in the riverside station a plain four-step series regulator, which is used to reduce the speed of the 130 brake horse-power motor below normal on the rare occasions when the level of water in the river makes so low a speed necessary. This is adjusted by hand when occasion arises. Formerly it was the custom to regulate the pump discharge on such occasions by throttling the 15-inch valve, but by slowing the motor below normal and leaving the valve fully open 10 per cent. better efficiency is secured and more silent running of the pump is obtained. The variation in speed by series resistance is so slight that it does not affect the starting up of the motor.

The total equipment for controlling the pumps and valves, as described above, cost less than £700, exclusive of cables. The annual saving in wages, disregarding the question of efficiency, is at least £500 per annum. This is because prior to the installation it was necessary to have one man in attendance 24 hours per day, seven days per week, this representing three whole-time men and half of one man's time on eight-hour shifts, but under the new working conditions the station is unattended except for oiling up, general examination of the motors and machines, or to vary the machine regulator (seldom oftener than once per week) to suit the yield of water from the river, these duties taking only a few minutes.

The method of operation is as follows. The first operation in starting up is to "crack" the valve—that is, to open it slightly in order to prime the pump. This is done by turning the lever of the Dean control station in the opening direction, leaving it thus for five or ten seconds, and then turning it to the "off" position, leaving the valve slightly open. Having done this, the operator then waits for one or two minutes until the pump is primed. He then turns the controlling lever to the "close" position and the valve recloses.

When the green signal lamp lights up, indicating that the valve is closed, the operator presses the "start" button which starts the motor and accelerates it to pumping speed. This occupies 10 to 12 seconds. When this time has elapsed he presses the "pick-up speed" button, and while keeping this button depressed he turns the Dean control station lever to the full open position, which, when reached, will be indicated by the lighting of the red signal lamp, and the lever is then returned to the mid or neutral position. The operator keeps the "pick-up speed" button depressed until the Venturi recording watermeter shows that the pump has picked up the water. When he sees the pen rise on the Venturi recording water-meter he releases the "pick-up speed" button and the motor continues running at the predetermined speed, which in the case of one pump may be anything between 950 to 1,150 r.p.m., and 930 to 1,100 r.p.m. in the case of the other pump. To shut down, the controlling lever on the Dean control station is turned to close the valve. When the lighting of the green signal lamp indicates that the valve is closed, the operator presses the "stop" button, and thereby brings the pump and motor to rest.

THE INSTITUTION OF AERONAUTICAL ENGINEERS.—At a meeting of this Institution held at the Engineers' Club on Friday, November 7, a paper discussing the question of "Steel *versus* Lighter Alloys," in connection with aircraft construction, was read by Colonel N. Belaiew. The author first dealt with the properties of the light aluminium alloys, and afterwards referred at some length to the importance of a correct fibrous structure in steel. He suggested that, for some particular purposes in aircraft construction, the last-mentioned material possessed advantages to which sufficient attention had not yet been given. The reading of the paper was followed by a discussion in which Professor Carpenter and a number of other speakers took part.

JUNIOR INSTITUTION OF ENGINEERS.—On Friday, November 7, Mr. H. C. Jones, delivered a lecturette on "Fire Engine Construction." He described the old forms of engines, the manual pumps, and later, steam pumps, many of which are still in operation to-day. The first petrol driven fire engine, he said, was built in 1903, and of course, was a considerable improvement on the steam operated engine because it could turn out to a fire and start pumping at once. Dealing with modern fire engines there were two types, one carrying a reciprocating pump and the other a turbine pump, a point about the latter being that it needed priming before it would begin pumping. This could be performed by means of an auxiliary air pump. An important item of fire engine equipment was what was known as the "First Aid." It consisted of small rubber hose with a small jet, supplied with water from a tank mounted on the engine body. This water might be forced out by a pump, by compressed gap, or by a CO_2 generator. This equipment was used for small fires and for getting a jet of water to work quickly.

NOTES ON NEW BOOKS.

ONE of our firmest convictions is that the British race has a longer and more tenacious memory than its Latin neighbours; but on reading Mr. Archibald Hurd's second volume of the official history of the merchant service during the war ("*The Merchant Navy*," vol. ii, John Murray, 21*s.* net), one is tempted to ask whether we have not overrated ourselves. Mr. Hurd has put on record the endurance and courage with which the merchant seamen faced the ordeal of German submarine warfare. What has become of the bitter indignation to which the whole nation was roused by the campaign against defenceless merchantmen; or of the anger with which they heard of the judicial murder of Captain Fryat? It may be that our national dislike of a vendetta is a sound instinct; but, it should not be allowed to make us forget the enormous danger from which we were extricated, not figuratively, but literally, by the courage and fidelity of British seamen. Mr. Hurd has done an immense service in making an intimate, detailed picture of the whole episode. The German submarine campaign threatened us in two ways: first, the naval staff at Berlin hoped to dislocate our whole system of sea-borne supplies by keeping ships in harbour; and it was only when this had been tried and had failed that they attempted to bring the nation to its knees by sinking more tonnage than could be spared. As has been said, there was literally no protection against the first threat except the unflinching resolve of the merchant captains to do their duty. Mr. Hurd's second volume describes the fortunes of the merchant seaman from the spring of 1915 to the first months of 1917, just before intensive submarine war began. Only a few of the episodes he deals with are familiar to us. We know roughly what happened during such sinkings as those of the Arabic and the Persia; for they were incidents in the diplomatic history of the war; but we know nothing of the numerous instances of resistance against overwhelming odds, and hair-breadth escapes, which make up the bulk of the volume. One is tempted to ask why effective naval protection was so slowly given to a service which endured so much; that is, why the convoying of merchant fleets was not introduced earlier in the day? The stories which Mr. Hurd has extracted from the official papers only prove one thing: that unassisted courage may earn honour, but cannot resist organised force indefinitely. The lesson to be drawn from the intermediate period of submarine warfare, with which Mr. Hurd is concerned, was, after all, overwhelming; the merchant service could not, on its own resources, resist German submarines. It was available only to those in high authority, and in spite of it the effective measure was not taken until almost too late. It is therefore to be hoped that Mr. Hurd's volumes will perform the double service of consoling, as far as can be, the widows, children and relatives of those who fell victims to an attack against which they could hardly defend themselves, by giving full details of the achievements of our lost seamen; and of making it impossible that the merchant service shall ever again be exposed to such a trial, by recording exactly what that trial was and what its consequences might have been.

To those who possess the true spirit of engineers, there are few recreations more delightful than an occasional hour spent among the records of the past, in the spiritual company of the men who laid the foundations of modern industry. The romance of their early efforts to "direct the great sources of power in nature to the use and convenience of man" without the aid of the organised knowledge which guides the advances of engineers to-day, and the boldness with which they acted upon their natural instincts of construction, are bound to interest and inspire those who seek to establish further progress. Several years ago the Newcomen Society was formed with the object of studying the early history of engineering, and rescuing from oblivion the records of early work before it is too late. The third volume of the Transactions of this Society, the Hon. Secretary of which is Mr. H. W. Dickinson, M.I.Mech.E., of the Science Museum, South Kensington, S.W.7, has now been published at the price of 20*s.* The society, under the Presidency of Mr. Loughnan Pendred, the editor of our contemporary, *The Engineer*, has done excellent work, and is worthy of the support of all those who care for the history of the struggles and triumphs of the early pioneers. It will be news to many that within the last century rectangular steam boilers 6 ft. square by 9 ft. 4 in. long, were constructed of 4-in. planks bolted together, the fire-boxes being of cast iron, and the flues of wrought iron plate. Mention of such boilers, driving engines with cylinders 20 in. diameter by 48 in. stroke, is made in a paper read by Mr. E. A. Forward on the work of Simon Goodrich, an Admiralty engineer, who died in 1847. Another extremely interesting paper reprinted in the Proceedings, is that of "The Early History of Steel-making in England," by Mr. Rhys Jenkins.

Sir George Cayley's early work on "Aerial Navigation" forms the subject of another interesting article by Mr. J. E. Hodgson, but it is impossible in a brief note to do more than call attention to the proceedings of a society whose functions are unique and entirely commendable.

For the purpose of carrying out many engineering undertakings it is often found necessary to lower the level of the subsoil water. The lowering can be effected by various means, chiefly by air pressure, freezing and continual pumping. In his treatise on "*Die Grundwasserabsenkung in Theorie und Praxis*," Dr. Ing. Joachim Schultze, of the Berlin Technical High School [Berlin: Julius Springer; price 1·45 dols.] deals particularly with the method of pumping. There has not been much improvement in this field since Kyrieleis published his book of a similar title in 1913, to which Dr. Schultze refers. But several notable installations have been put down, and further experience has been gained as to suitable machinery and materials. One of the earlier instructive failures in this connection was the first attempt of tunnelling the Spree for the Berlin electric underground railway. Dr. Schultze describes this and other installations by German firms; in one case the water level had to be lowered by 45 ft. and in the construction of a third canal lock at Wemeldinge, Holland, 49 wells had to be sunk, the lowering required amounting to 26 ft. The well points are generally made of wrought iron, hot-galvanised inside and perforated in parts; the perforations are wrapped with fine metallic texture, the best being of copper, with iron wire coils interposed.

Welding by the electric arc is resorted to in many trades and provides a valuable means of carrying out repair work. The process is dealt with in detail in a very handy guide, measuring 7½ in. by 5½ in., containing 132 pages, entitled "*La Soudure Electrique à l'Arc Métallique*," by Mr. S. Frimaudeau, published at the price of 10 francs by Messrs. Gauthier-Villars and Co., Paris. The book gives a short review of the theory of the electric arc and describes electric welding by the metallic arc for building up, joining together, or repairing iron, cast iron and steel mechanical parts, by melting down at the spot a piece of iron rod, the rod being either naked or, preferably, coated with various substances, silicates generally forming the basis of the coating. The component parts of a welding installation, its location and the operations involved are described for both continuous and alternating current, the characteristic features, efficiency and advantages of typical installations being detailed. Semi-automatic and automatic arc welding machines are also dealt with. An especially interesting chapter is one which describes the X-ray examination of welds, a method of inspection which forms a useful complement to all the other usual tests. This is an excellent, practical hand-book on the subject; it is carefully printed and illustrated, and is likely to be greatly appreciated.

Foundry work offers little attraction to the collar-and-cuffs young man. It is dirty and laborious during the preparation of the moulds, hot and suffocating at casting time. The pay of the rank and file is not high. Laboriously acquired manual skill is being extensively displaced by the mechanical output of the moulding machines. Yet, once a man has got through the wearisome bitterness of his learning, the drudgery becomes lightened by awakening interests. The science of metallurgy—many-sided in its aspects—makes an appeal at every stage of the work. Economical problems press for solution every day. Alternative methods and ever-varied details in the making of moulds present themselves. Then, for the few men who reach the top, the prizes are substantial. These can make big profits for a firm, and become as nearly indispensable as men may hope to be. Probably, as the years go on, the craft of the moulder will become magnified, and the old opprobrious epithet of "sand rat" be forgotten. For a beginner, who desires to learn what manner of craft this is, "*Foundry Work*," by Mr. W. Roland Needham (Blackie and Son, Limited; price 2*s.* 6*d.*) can be recommended. It is a small volume of 146 pages with 92 illustrations; but it is packed with information, stated concisely, and should prove of valuable assistance to those interested. Sands, tools, metal, plant, are treated with brevity, after which the work of moulding is taken up in its several branches, including the elements of machine moulding. Short chapters on steel and brass founding are included. Each chapter concludes with a series of questions to test the student's knowledge; these are of a crucial and practical character, dealing with fundamentals. The book is a good and comprehensive one.

The second volume of the "*Lehrbuch der Elektrotechnik*," edited by Professor Esselborn (Leipzig: Wilhelm Engelmann; price 24*s.* 6*d.*), deals with electric power stations, high-tension installations and transmission, uses of electric motors, electric heating and lighting and electric signalling, telegraphy and telephony, including radiotelegraphy. It is clear that a compendium of this compass, even when a large volume of 826 pages with 1,900 illustrations, cannot go into great detail, and will mainly have to serve as an introduction for the young electrician. Several of the compilers are departmental chiefs of the Siemens-Schuckert works. The general treatment of this second edition of the book is commendable. The text and literature references at the ends of the sections show that the matter has been brought up to date. The section on radiotelegraphy has, however, not been much improved by the one page on radiotelephony and the final paragraphs on the actual state of radiotelegraphy.

The process of manufacturing hollow steel pieces, starting from an ingot pierced hot under a vertical press, the blank being then drawn down through dies in a horizontal one, was in operation in this country long before the war. Our extensive manufacture during the war of shells and gun parts on this same process has brought about, among other results, marked improvements in steel making and teeming. The full interchange of views by steelmakers of the Allied countries whilst the war lasted was particularly valuable in directing attention to methods of manufacture which have led to the production generally of ingots of greater soundness, and ingots from which the discard is less than was hitherto the case. The experience thus gained has been used since in the manufacture on a very large scale, and in more economical conditions, of improved tubular articles for engineering and industrial purposes; a number of such articles could be seen at the recent Empire Exhibition, together with others obtained from cupped steel plates, also non-ferrous articles obtained by similar processes and specimens of wire drawing. Wire drawing is a much older process. The manufacture of wire by the use of draw-plates was commenced about six centuries ago, and many of the more recent improvements, such as "patenting," originated in this country. Both these industries, namely, drawing down and wire drawing, also the kindred "extrusion" process discovered by Mr. Dick, the founder of the Delta Metal Company, Limited, are dealt with in "*Principes Généraux de l'Etirage et du Tréfilage*," by Mr. G. Soliman, a book published at the price of 15 francs by Messrs Gauthier-Villars and Co., Paris. In this the author enters in detail into the questions arising in drawing down and wire drawing, and into the effects of cold work and of annealing, particularly in regard to wire drawing. The first chapter is on the properties of metallic products, and deals with the various tests applicable to those under review. The questions of annealing and cold work are then examined in detail in the case of various metals, the author pointing out the results they give under varying conditions as to temperature and time. Then follow chapters on drawing down, wire drawing and straightening, with details on lubrication, rate of flow, pickling, &c. The publication is a very handy and complete guide in French on important processes of manufacture. Interesting data concerning many of these can also be found in papers read at different times before the various technical societies.

Treated as a text-book for students, a book on "*Factory Costing*" (Constable and Co., Limited, 10–12, Orange-street, W.C. 2; price 7*s.* net) justifies its publication much more than have some works purporting to be textbooks and vade-mecums which have come under our notice recently. In this book the author, Mr. H. H. Emsley who clearly has fairly wide knowledge of the subject upon which he is writing, starts right at the beginning and deals with his subject in such a manner that the youngest or most uninformed student should be able to follow him. After dealing with the elements of cost and the costing of material, labour and oncost are discussed in quite a satisfactory manner. Chapters are devoted to factory organisation and routine, the costing system; and, what is of very real importance, emphasis is laid upon the use of cost data in management. The discussion of oncosts is more intelligent and helpful than is often the case, the advantages and disadvantages of the various methods of apportioning the different expenses which go to make up oncosts being quite usefully treated. In dealing with the percentage on the "direct labour cost" method of apportionment, the situation is summed up as giving true results only when: (1) the oncosts are departmentalised, *i.e.*, ascertained for each production department separately; (2) the rate of pay of direct wage-earners is more or less uniform; (3) the machines in the separate departments are uniform with respect to their running expenses. This may not cover the whole ground, but it is quite a useful basis which many who do not come under the heading of students might quite well consider. While, perhaps, the author does not keep strictly within the title of his book, his references to planning, progress, payment by results, and factory organisation generally will be found by no means unhelpful, and we feel that the student, whether he be a budding manager or accountant, will find the time spent in reading amply repaid.

BOOKS RECEIVED.

Handbuch zum Dampffass-und Apparatebau. By G. Honnicke. Berlin: Julius Springer. [Price 15 gold marks.]

United States Bureau of Standards. Handbook No. 5. *American Logging and Sawmill Safety Code.* [Price 60 cents.] Washington: Government Printing Office.

The Waste of Capitalism. Report of the Committee into Production, &c., set up by the National Joint Council. London: Labour Joint Publications Dept. [Price 1*s.* 6*d.* net.]

A System of Physical Chemistry. Vol III. *Quantum Theory.* By William C. McC. Lewis, M.A., D.Sc. Third edition. London: Longmans Green and Co. [Price 15*s.* net.]

Optical Measuring Instruments. Their Construction, Theory and Use. By L. C. Martin, F.R.A.S., D.Sc. London: Blackie and Son, Limited. [Price 17*s.* 6*d.* net.]

Des Lokomotiv-Ingenieurs Taschenbuch. Berlin: Julius Springer. [Price 5 gold marks.]

La Soudure Electrique à l'Arc metallurgique. By S. Frimaudeau. Paris: Gauthier-Villars et Cie. [Price 10 francs.]

Managements Handbook. L. P. Alford, M.E. Editor in Chief. New York: The Ronald Press Company. [Price 7 dols. 50 cents.]

The Motor Manual. Twenty-fifth edition. London: Temple Press, Limited. [Price 2*s.* 6*d.* net.]

Small Electric Generating Sets. Employing Internal-combustion Engines. By W. Wilson, M.Sc. London: Ernest Benn, Limited. [Price 18*s.* net.]

Aeronautical Research Committee. Reports and Memoranda. No. 902. *Air-Hydrogen Explosions in Closed Vessels.* By R. W. Fenning, B.Sc. [Price 2*s.* net.] No. 913. *The Distortion of a Stiff-jointed Plane Polygonal Frame under Loads Applied in its Plane.* By Professor A. J. Sutton-Pippard, D.Sc., and P. Field Foster, B.Sc. [Price 1*s.* 3*d.* net.] No. 914. *Note on the Application of the Vortex Theory of Aerofoils to the Prediction of Downwash.* By L. F. G. Simmons, B.A., and E. Ower, B.Sc. [Price 6*d.* net.] London: His Majesty's Stationery Office.

Department of Oversea Trade. Report on the Commercial Industrial and Financial Situation in Japan and Her Dependencies in 1923 and up to June, 1924. By G. B. Sansom and W. J. Davies. London: His Majesty's Stationery Office. [Price 2*s.* 6*d.* net.]

Department of Overseas Trade. Report on the Commercial, Industrial and Economic Situation of China. June, 1924. By H. J. Brett. London: His Majesty's Stationery Office. [Price 1*s.* 6*d.* net.]

Principes Généraux de L'Etirage et du Tréfilage. By G. Soliman. Paris: Gauthier-Villars & Cie. [Price 15 francs.]

Switchgear for Electric Power Control. By E. Basil Wedmore, M.I.E.E., and Henry Trencham. London: Humphrey Milford. [Price 25*s.* net.]

Lehrbuch der Nomographie auf abbildungsgeometrischer Grundlage. By H. Schwerdt. Berlin: Julius Springer. [Price 12·90 gold marks.]

Handbuch der Ingenieurwissenshaften. Part IV. *Die Baumaschinen.* Chapter II. *Der Schachtbau.* By O. Stegemann. Third edition. Leipzig: Wilhelm Engelmann. [Price 9 gold marks.]

Recent Progress in Engineering Production. By C. M. Linley. London: Ernest Benn, Limited. [Price 42*s.* net.]

Structural Design in Steel Frame Buildings. By Percy J. Waldram. London: B. T. Batsford, Limited. [Price 12*s.* 6*d.* net.]

Regulations of the London County Council relating to Reinforced Concrete and Steel Framed Buildings. By Ewart S. Andrews, B.Sc. London: B. T. Batsford, Limited. [Price 4*s.* net.]

Structural Engineers' Handbook. By Milo S. Ketchum, C.E., M.Am.Soc.C.E. Third edition, enlarged. London: McGraw Hill Publishing Company, Limited. [Price 35*s.* net.]

The Constituents of Coal Tar. By Percy Edwin Spielmann, Ph.D., B.Sc. London: Longman's Green and Company. [Price 12*s.* 6*d* net.]

A History of Bleaching. By S. H. Higgins, M.Sc. London: Longmans Green and Company. [Price 10*s.* 6*d.* net.]

United States Bureau of Standards. Scientific Papers No. 491. *Theory of Determination of Ultra-Radio Frequencies by Standing Waves on Wires.* By August Hund. [Price 15 cents.] No. 492. *Formulas, Tables, and Curves for Computing the Mutual Inductance of Two Coaxial Circles.* By H. L. Curtis and C. M. Sparks. [Price 15 cents.] Washington: Government Printing Office.

Railway Electrification. By H. F. Trewman, M.A. London: Sir Isaac Pitman and Sons, Limited. [Price 25*s.* net.]

The Electrical Contractors' Year Book, 1924-1925. London: The Electrical Contractors Association. [Price 2*s.* 6*d.* net.]

Auxiliary Tables of the Survey of India. Part I. *Graticules of Maps.* [Price 2*s.* net.] Part II. *Mathematical Tables.* [Price 4*s.* net.] Part III. *Topographical Survey Tables.* [Price 3*s.* net.] By J. de Graaff Hunter, M.A., D.Sc. Fifth edition revised and extended. Dehra Dun: Office of the Trigonometrical Survey.

STEEL CONSTRUCTION WITH THE USE OF TUBULAR MEMBERS.

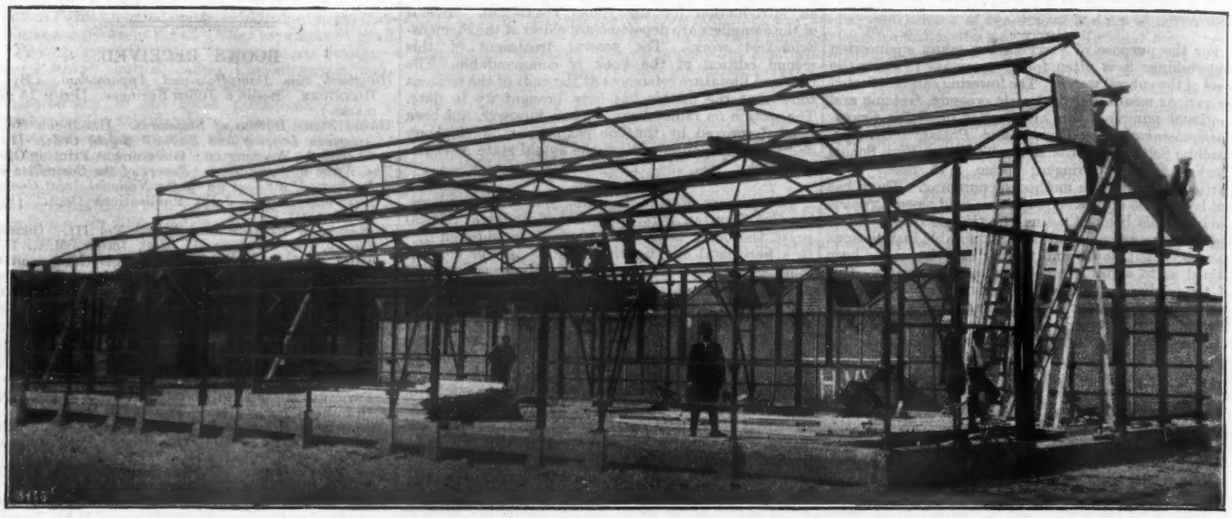


FIG. 1. TUBULAR STEEL FRAMEWORK OF A BUILDING AT LAAKHAVEN, THE HAGUE.

INDIAN INSTITUTE OF SCIENCE.

THE Indian Institute of Science, of Bangalore, is the premier institute of research in India. It was established 15 years ago, by the munificent gifts of the late Sir Jemshedji Tata, and is now receiving annual grants from the Mysore Government and from the Government of India. Three main principles are observed in selecting the problems to be investigated at the laboratories: (1) to afford opportunities for acquiring experience in the application of research methods; (2) to effect improvements in manufacturing processes; and (3) to promote the use of natural products or materials for the national benefit.

The annual report of the Institute for the year ending March 31, 1924, shows that considerable progress is being made in research work. One of the investigations taken up at the Institute since its foundation is connected with fixed and essential oils which comprise a very substantial part of Indian natural resources. During the year work done in, this connection consisted of the examination of oils of neem, hongay, cashew-kernel, rape, rocket, mustard and rayan. Work also is in progress on the relation between the iodine values and refractive indices of hardened and partially hardened oils. As regards essential oils, work on ginger-grass and kachoora-root has been continued, and progress made towards producing vanillin from eugenol. Successful experiments were also made in manufacturing ether.

Another department of research is that connected with bio-chemistry, which embraces a variety of subjects having practical value in the development of Indian resources. The prominent work that is being done has regard to the chemical physiology of the lac insect, and the Mysore Government has placed a plantation at the disposal of the Institute so as to carry on concurrently laboratory work with forest practice. It has been practicable in this plantation to study the parasites of the lac insect, and to vary the methods of inoculation in accordance with seasonal conditions and the ability of the host-plant to provide nutriment. Meanwhile, a new host-plant has been found, and a plantation of 200 has been grown at the Institute, from the observation of which it is anticipated that valuable results may follow. A survey of the changes accompanying oil development in the seeds of *Bassia longifolia* (mahua) has been completed, while work on examination of yeasts and enzymes is in progress and varieties of malted food have been produced.

In the department of the electrical technology many valuable new appliances have been assembled, several of which have relation to recent development in wireless telegraphy. The incandescent filament cathode-ray oscillograph has been used for delineating the wave-form of high-frequency alternating currents, and a high-frequency generator for laboratory and industrial purposes is being constructed. Apparatus has been designed for directly measuring harmonics in the magnetising current of electrical apparatus, and a variety of experiments on condensers, induction motors and thermionic valves have been conducted. The equipment has been increased by the gift of a motor generator from Messrs. Mather and Platt, Manchester, and by the presentation of several pieces of electrical apparatus by Professor Catterson-Smith.

In the department of the mineral chemistry, work continued on the Indian zirconium ores, and the concentration and briquetting of chrome and manganese ores. There has been some extension of the work on the formation and the composition of chromates, while refining of saltpetre has been completed.

TRANSPORT IN FRENCH AFRICAN COLONIES.

Two French colonial governors have recently issued reports upon the importance of developing transport in French Africa, and the difficulty of doing it. The first is Monsieur Carde, the Governor of French West Africa; and the second, Monsieur Hesling, the Governor of the Upper Volta. At present, French West Africa possesses two railways: the coastal line joining Saint Louis and Dakar, and the inland line which unites the Senegal River, at Kayes, to the upper Niger at Bammako. There is only one line in the French Gold Coast: starting at Bingerville (little Bassam) it runs northward for a distance of about 150 miles to the foot hills of the Koa mountains. Four hundred and fifty miles north of this lies the upper Volta region, with its principal town, Onagoudou. The district is extremely fertile; both the French governors insist on the importance of connecting it by railway to the Gold Coast region, and quote remarkable statistics to show how rapidly native agriculture expands in any district which is supplied with proper transport. At present there are about 500 hand carts, and 32 automobiles in the Upper Volta region, and the quantities of goods transported in 1924 will be about double the figure for the previous year. On the other hand the cost of extending the existing Gold Coast railway to the southern part of the Upper Volta region would be very heavy; Monsieur Carde estimates that the permanent way alone could not be built for less than one hundred and sixty million francs. He hesitates to raise the money by taxation, and doubts whether he could float a loan successfully. The line between Kayes and Bammako emphasizes the point which both the French Governors have insisted upon so much. In the hope of encouraging traffic, the tariff charges were made as low as possible (0·13 franc per mile per head); those on the Saint Louis-Dakar line were about four times as much. The outcome has been that native produce has so increased in volume that the railway lacks the means of transporting it. The French demand for the arachis nut, which is grown in the region traversed by the railway, so far exceeds the supply that the price has quadrupled itself in a few years.

It will be a slow business to give the French African colonies all the railways they require; but in the meanwhile, the governors are doing everything in their power to increase harbour facilities. The Saloum river bar to the south of Dakar is to be dredged at a cost of 300,000 francs, and 24 million francs are to be laid out in expanding the harbour of Vridi. On this point also, the French governors can quote striking statistics; if the Saloum bar is only made 2 ft. deeper, the smallest coastal steamer which ordinarily visits the harbour will be able to carry 240 extra tons per voyage.

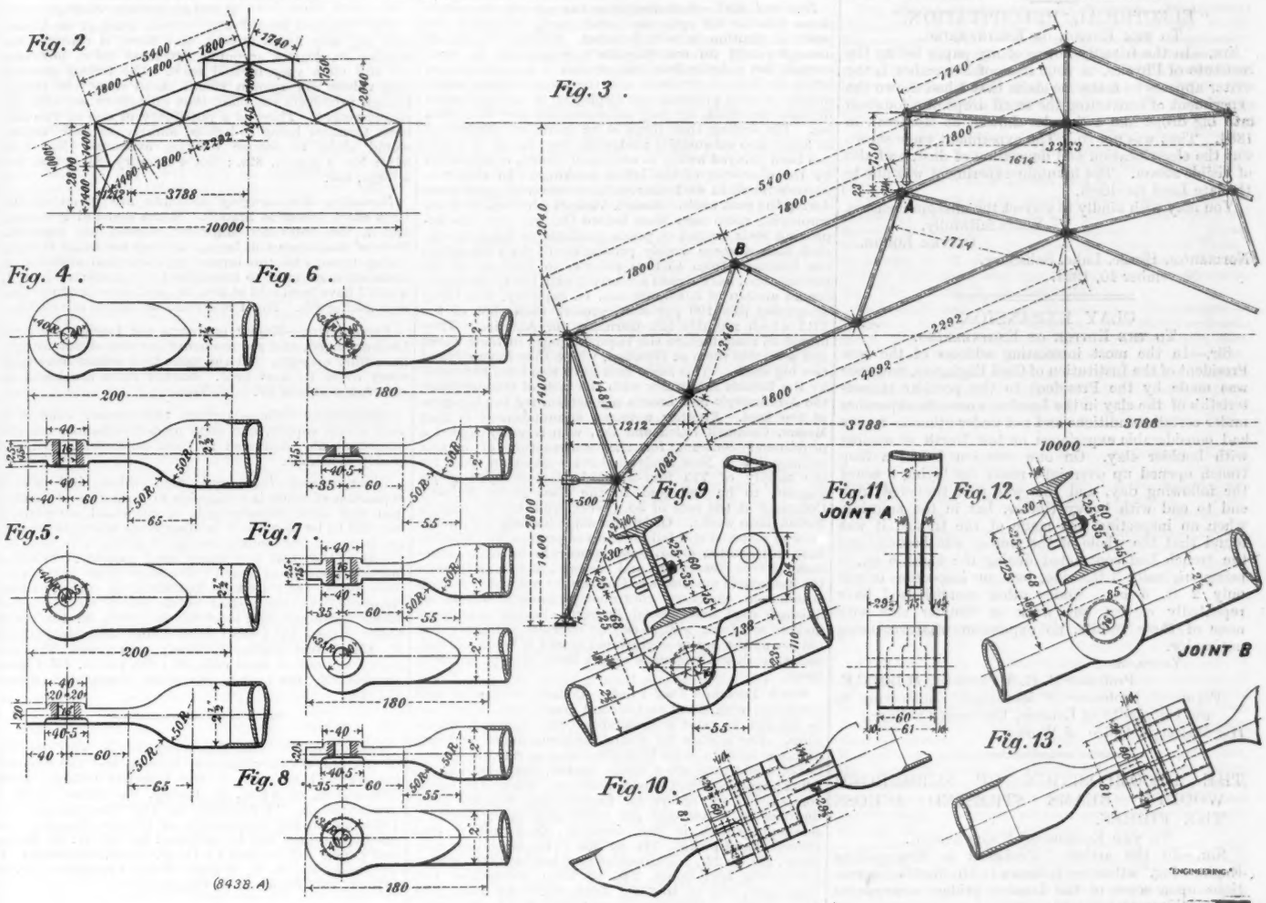
STEEL CONSTRUCTION WITH THE USE OF TUBULAR MEMBERS.

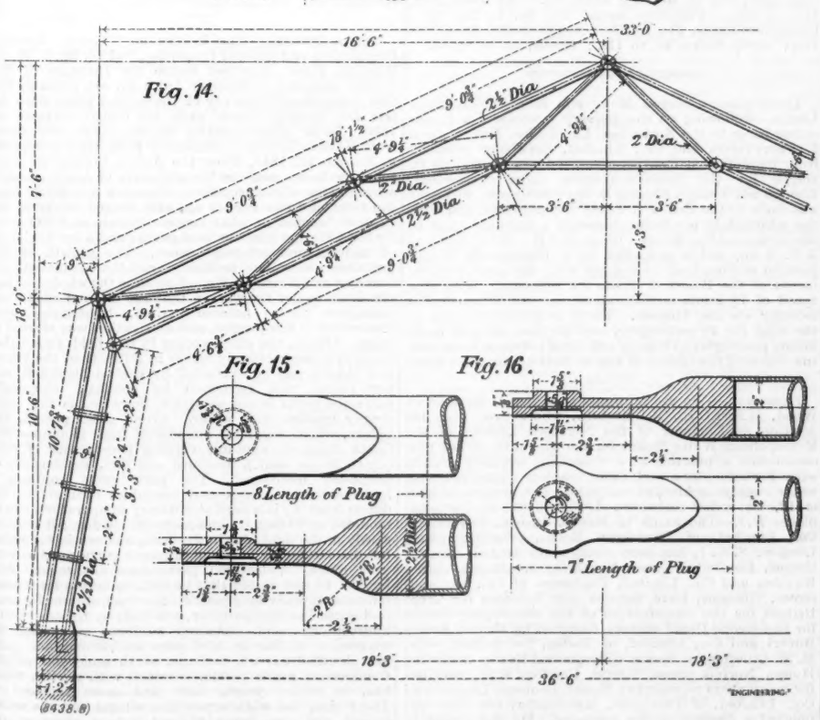
THE tubular form has many advantages over ordinary rolled sections in the economic use of steel in a building, and for that reason many engineers have attempted to devise means of connecting the components, to make the use of tubes a practical possibility. Some progress has been made by Dutch engineers, and we illustrate on this and the opposite page examples of structures which have been built by their methods. For the drawings and the photograph from which these illustrations were prepared we are indebted to Mr. J. E. Obreen, of the Pluto Stoker Company, 2, Upper Westbourne-terrace, London, W. 2, who is concerned with the development of the system.

The general appearance of the steel frame of a shed built up with tubular components may be appreciated from Fig. 1, which represents an erection which was recently put up at Laakhaven, The Hague. In this building the uprights are tubes of 3 in. and 4 in. diameter, the rafters and tie bars are similar 2½-in. tubes, while the diagonal members of the roof trusses are made of 2-in. diameter tubes. This structure, of which the key plan of the truss is shown in Fig. 2, page 675, has a span of 10 m. (32 ft. 9½ in.) and a length of 25 m. (82 ft. 2½ in.). From the key plan and Fig. 3, which shows the assembled truss, it is obvious that the structure is completely composed of triangles. These are made up of short lengths of tube provided with solid ends, connected to each other by pin joints.

For the construction of the components of each truss the tubes are cut to the lengths required, and then plugs of Siemens-Martin steel are inserted at the ends. The protruding plugs and the ends of the tubes are then heated until they are white-hot, when they are pressed into complete union with each other, and the ends of the plugs are, at the same time, pressed into flat discs. Once this operation is completed, the bolt holes are drilled and depressions or projections are machined around the bolt holes, which are used to obtain good bearing relationship between the parts when they are later assembled. The forms of the end pieces used for rafters and tie-rods are shown in Figs. 4 and 5, while those for the various diagonal members of the truss are to be seen in Figs. 6, 7, and 8. Where the purlins cross the principals, brackets of special form are necessary, and these for two positions, marked A and B in Fig. 3, are shown in Figs. 9, 10, and 11 and in Figs. 12 and 13, respectively. For position A, the bracket, which is used for the support of the purlin, has an extension for the provision of a pin joint

STEEL CONSTRUCTION WITH THE USE OF TUBULAR MEMBERS.





to the vertical member of the frame for the lantern on the roof. Apart from the lugs referred to, the brackets for the accommodation of the other purlins, such as that which is located at the position on the truss marked B in Fig. 3, are of similar design and are also bolted to the purlins (see Figs. 12 and 13). It should be noted that the dimensions given in the illustrations, Figs. 2 to 13, are in millimetres, with the exception of the diameters of the tubes, which are in inches. Endeavours have been made to introduce this system of steel construction into Britain, and an example, which was recently erected at Clapham Common, London, is shown in Figs. 14 to 16. In these illustrations the details and dimensions, in feet and inches, are given for a shed which has a floor width of 36 ft. 6 in. and a span of roof truss of 33 ft. The roof principal in this case is pin-jointed at each end to a pair of inwardly inclined, but parallel, tubes which are connected by three tie-bars. From Figs. 15 and 16 the standard sizes, in English units, adopted for the tube ends may be seen.

The advantages claimed for this method of building up structures are many. Equal strength to a rolled-section construction is obtained with the use of less weight of material. The components are comparatively cheap, and their assembly is easy and entails the expenditure of little labour. The tubes, that are used to form the trusses, once the plugs are welded in and bored, may be as easily assembled on the site as in the works, and if that is done cheap transport is possible. A further claim made for the system is the elimination of troubles due to faulty riveting. In the case of temporary erections it is certainly an advantage that by the removal of the bolts and nuts the framework may be dismantled and its components used for other structures, or for the same one re-erected on another site. The method is, of course, applicable to the erection of all types of sheds as well as other structures, such as small bridges, scaffolds, &c.

MATERIALS FOR ROCK DUSTING COAL MINES.—A survey of the sources of limestone, gypsum and anhydrite, contiguous to coal mining districts, has been completed by mineral technologists of the Interior Department on the staff of the United States Bureau of Mines. This survey was undertaken at the request of coal mine operators, in order that they may know where to obtain suitable materials for rock dusting coal mines to prevent explosions from coal dust. This survey is part of the vigorous campaign being carried on by the bureau to encourage the use of rock dust in all coal mines having an explosion hazard. Excellent progress is being made in this campaign with the help of coal mine operators all over the country.

LETTERS TO THE EDITOR.

"ELECTRICAL PRECIPITATION."

To the Editor of Engineering.

Sir,—In the friendly notice of my paper before the Institute of Physics, in your issue of November 7, the writer appears to make me claim that I had shown the experiment of converting the small drops of a fountain into big drops like a thunder-shower, at Montreal, in 1884. That was not so. The experiment there shown was the electrification and deposition of dust, and also of visible steam. The fountain experiment was due to the late Lord Rayleigh.

You may wish kindly to correct the misapprehension.

Yours faithfully,

Oliver Lodge.

Normanton House, Lake, Salisbury.
November 10, 1924.

CLAY EXPANSION.

To the Editor of Engineering.

Sir,—In the most interesting address of the new President of the Institution of Civil Engineers, reference was made by the President to the peculiar characteristics of the clay in the London area—its expansion under certain conditions and not under others. I have had considerable experience in the North in dealing with boulder clay. On one occasion I had a long trench opened up overnight ready for laying a sewer the following day, and this was well timbered from end to end with heavy timber, but in the morning, when an inspection was made of the trench, it was found that the whole of the timber was broken, and the trench had contracted during the night 6 in., it being originally 3 ft. wide, but on inspection it was only 2 ft. 6 in. Under other conditions I have repeatedly carried out work in boulder clay with none of these results, no expansion whatever being noticeable.

Yours, &c.,

Professor E. R. Matthews, M.Inst.C.E.
(Formerly Professor of Municipal Engineering in the University of London, University College.)
His Majesty's Office of Works.

THE DECOMPOSITION OF SUBMERGED WOODEN BEAMS STRESSED ACROSS THE FIBRES.

To the Editor of Engineering.

Sir,—In the article "Problems in Metropolitan Engineering," attention is drawn to Mr. Mott's observations upon some of the London bridges constructed during last century.

Three of these bridges have subsided several inches owing to the deterioration of certain beams used in the construction of their foundations, although it is admitted that there are instances of wooden piles found to be sound after remaining immersed in fresh water for periods so long as eighteen centuries. But it has already been pointed out that the timbers, which have remained in use for such a length of time, have been stressed along the fibres, whereas the beams, which have failed in the foundations of certain Thames bridges, have been stressed across the fibres.

I would suggest that there is a physico-chemical reason for the comparatively short life of beams when stressed across the fibres, especially when immersed in water. The fibres stressed unequally when loaded at right angles to their length are displaced, thereby causing the cell walls, which are considerably weaker under a compressive stress across the fibres, to be broken, because the stress is taken both by the softer parts of the timber and the fibres alike. Micro-organisms, which would be unable to enter if the cell walls remained whole, can pass through the broken cell walls, permeating the beam. These organisms set up decay and fermentation, the products of which dissolve in the surrounding water and are carried away, causing the beam to collapse. When in the more natural condition of compression, with the fibres taking the stress along their length, the beam is more capable of withstanding such stress and the cell walls are not disrupted by the load.

The oxygen dissolved in the water flowing past a vertical pile oxidises any vegetable acids, &c., immediately they may form on the surface of the wood, but in the case of a horizontal beam with broken cell walls, the internal area exposed is so great that the water which enters carries an insufficient volume of oxygen to oxidise these products of decomposition, which do much to make further decay so rapid.

Yours, &c.,

J. Vernon Shaw.

The Institution of Electrical Engineers.—The Council of the Institution of Electrical Engineers have elected Sir Oliver Lodge, D.Sc., F.R.S., to be an Honorary Member of the Institution.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

Iron and Steel.—Sufficient time has not yet elapsed to prove whether the optimism based on the change in the political position is well founded. Official returns of unemployment do not indicate any increase in gross output, but judging from the number of inquiries circulating for finished products and the wider interest which makers of such products are displaying in raw and semi-finished materials, an early improvement may be looked for. The feeling that there is an increased disposition to enter into substantial contracts, the placing of which has been delayed owing to economic causes, is supported by the character of the latest bookings. In this connection Sheffield and district have received good news during the past week. Messrs. Vickers Limited, who are employing more men than before the war and are improving their output of peace products so substantially that their average weekly production of drop stampings has increased from 40 tons pre-war to 155 tons at the present time, have signed a contract with the Government for an airship of 5,000,000 cub. ft. capacity, this being something like 100 per cent. greater than that of the ZR3 which recently left Germany for America. They intend to manufacture the requisite parts in their works and assemble them at Howden, where they have secured two big sheds. This same firm have also been entrusted by the British Admiralty with the task of standardising the Admiralty's new breech mechanism for the big guns of the fleet. Another welcome announcement is that Messrs. Cammell Laird and Co., who recently signed a provisional contract for the construction of a new railway line in New Zealand, have booked an order for the supply of 775 four-wheeled all-steel open goods wagons, to be delivered to the East India Railway Company at the rate of 50 a week from the company's Nottingham works. Orders for ship steel and for foreign railway material still fall far short of productive capacity, but, on the other hand, there appears to be an improvement in tram trackwork and castings, and anxiety as to the immediate outlook is to that extent relieved. British automobile engineers continue prominent buyers of finished steel and special fittings. Textile machinery makers are doing well in certain overseas markets; but output at the heavy engineering works is below normal, and agricultural engineers report little, if any, improvement.

South Yorkshire Coal Trade.—Colliery sidings are still congested with small and second grade fuels, which can be bought at rates considerably below nominal quotations. The market for steam hards continues moderate on home account, with little alteration as regards export. Cobbles and nuts are a shade weaker, business in slacks being largely confined to best qualities. There is increased competition for orders for furnace and foundry coke. Supplies of house coal are fairly abundant, despite a seasonal growth in the demand. Quotations: Best branch hand-picked, 32*s.* to 35*s.*; Barnsley best Silkstone, 26*s.* to 28*s.*; Derbyshire best brights, 27*s.* to 32*s.*; Derbyshire best house, 24*s.* to 26*s.*; Derbyshire best large nuts, 22*s.* 6*d.* to 25*s.*; Derbyshire best small nuts, 14*s.* to 16*s.*; Yorkshire hards, 21*s.* 6*d.* to 23*s.* 6*d.*; Derbyshire hards, 21*s.* to 23*s.*; rough slacks, 9*s.* 6*d.* to 12*s.*; nutty slacks, 9*s.* to 11*s.*; smalls, 6*s.* to 8*s.* 6*d.*

Thornycroft Motor Boat for Holland-America Liner.—Following on the delivery recently of a 42-ton motor barge to the Rotterdam Lloyd Line, Messrs. John I. Thornycroft and Co., Limited, have now supplied from Hampton-on-Thames, a ship's motor boat of 30 ft. length for the Holland-America Liner Rotterdam. Though not a ship's lifeboat in the strict sense, this boat was built to the Board of Trade requirements, and with the addition of air tanks, becomes a standard type of life-saving craft. It has a beam of 9 ft., and a depth of 3 ft. 9 in., and is propelled by a Thornycroft 30-h.p. paraffin engine, built to comply with the latest requirements of the Board of Trade for lifeboats. With it a speed of 7½ knots is maintained, as was demonstrated recently on the Thames. There is accommodation in the boat for 40 passengers, and its first use will be in taking passengers to islands and other places of interest in the course of the cruises of the ss. Rotterdam in the East.

Personal.—We are informed that Mr. J. Mackworth Wood, M.Inst.C.E., M.I.Mech.E., who retired from his position as Engineer of the Northern District of the Metropolitan Water Board on the 31st ultimo, has now established a practice as a consulting engineer dealing with Parliamentary and other matters connected with water supply or kindred subjects. His present address is 12, Cavendish-mansions, Langham-street, Portland-place, W.1.—The name of Messrs. Brown, Boveri and Co., Limited, of Trafalgar House, Waterloo-place, London, S.W. 1, has been changed to British Brown-Boveri, Limited, as from November 3.—Messrs. James Howden and Co., Limited, Engineers, of 195, Scotland-street, Glasgow, have become sole licensees for Great Britain for the manufacture of the scavenging blower for two-stroke Diesel engines, designed by Messrs. Brown Boveri and Co., Limited, of Baden, Switzerland.—Mr. M. M. Gillespie, of Messrs. Gillespie and Beales, Amberley House, Norfolk-street, Strand, London, W.C., who has for many years represented Messrs. Browett, Lindley and Co., Limited, of Patricroft, Manchester, has been appointed a director of the company. He will attend to business at the above address.—The London office of the technical journal *Combustion* has been removed from Aldwych House to Africa House, Kingsway, London, W.C.2.—The Robert W. Hunt Company have removed from 52, Queen Victoria-street to 34-40, Ludgate-hill, E.C. 4.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Trade.—Home demand for Cleveland pig iron keeps steady, and there is rather more inquiry on export account. Overseas sales, however, are still on a very limited scale. The feeling prevails that values will remain round about rates now ruling, though producers complain that quotations are still unremunerative. There is a possibility of one or two idle blast furnaces being re-lighted shortly, as such action would assist to reduce working expenses. No. 1 is 87*s.*; No. 3 g.m.b., 82*s.*; No. 4 foundry, 81*s.*; and No. 4 forge, 80*s.*

Hematite.—Encouraging accounts are given of the East coast hematite branch. Home demand is steady, and a few sales for shipment abroad are reported. Makers' stocks are still large, but they are being steadily drawn upon, and the improving statistical situation is assisting materially to strengthen the market. Nos. 1, 2 and 3 have been sold at 88*s.* 6*d.*, and some producers are now asking 89*s.* No. 1 is quoted 6*d.* above mixed Nos.

Foreign Ore.—Heavy contracts for foreign ore have been arranged, and requirements are stated not to have been fully met yet. At the same time sellers have large carry overs to next year. Market rates are based on best rubio at 22*s.* 6*d.* c.i.f. Tees.

Blastfurnace Coke.—Durham blastfurnace coke is in very ample supply, and good medium qualities are still offered at 25*s.* delivered to local consumers. Demand is only moderate.

Manufactured Iron and Steel.—Slow but steady expansion of trade is noticeable in a number of finished iron and steel departments. Continental competition has still to be faced, but producers are now making contracts over a few months instead of selling from hand-to-mouth as they had been doing until recently. Principal market quotations stand: Common iron bars, 12*l.*; iron rivets, 14*l.*; packing (parallel), 8*l.* 10*s.*; packing (tapered), 11*l.* 10*s.*; steel billets (soft), 8*l.* 10*s.*; steel billets (medium), 9*l.*; steel billets (hard), 9*l.* 10*s.*; steel boiler plates, 13*l.*; steel ship, bridge and tank plates, 9*l.* 15*s.*; steel angles, 9*l.* 10*s.*; steel joists, 9*l.* 10*s.*; heavy sections of steel rails, 9*l.*; fish plates, 13*l.*; black sheets, 12*l.* 10*s.*; and galvanised corrugated sheets, 17*l.* 10*s.*

Ionization in the Atmosphere.—A joint meeting of the Royal Meteorological Society and the Physical Society will be held at the Imperial College, South Kensington, at 5 p.m. on Friday, November 28, for a discussion on "Ionization in the Atmosphere; the Influence on the Propagation of Wireless Signals." An opening address will be delivered by Dr. W. H. Eccles, and papers will be read by Dr. C. Chree, Professor E. V. Appleton, Mr. R. A. Watson Watt, Professor C. T. R. Wilson, and Professor S. Chapman.

Gutta Percha.—The lecture on "Gutta Percha; Preparation and General Properties," which Mr. C. W. H. Howson, B.Sc., delivered before the Institute of the Rubber Industry on Monday, 3rd inst., was probably the first comprehensive survey of the subject given since the late Dr. Ludwig Obach gave his Cantor lectures in 1886. Other gutta percha articles, first introduced from Malacca by José d'Almeida in 1556, did not reappear in Europe till 1843, when the Asiatic Society received some specimens, and the Royal Society of Arts appointed a committee of investigation. Hancock and Silver took the rival of India rubber up, and started works in the East of London in what became known as Silvertown. By 1847 Werner Siemens used gutta percha for insulation of underground telegraph wires. The growth of the gutta trees is confined to Malacca and the islands between Sumatra and Borneo. For a long time the whole tree was cut down to get the sap, so that the original gutta tree (palagium gutta) became extinct. Substitutes were discovered in the jungles, and cultivation was started in Java. Obach, the chief worker in this field, found that the leaves are relatively richer in gutta than the trunk, and that it can be extracted by carbon bisulphide and hot petrol, and recovered by cooling; chemically extracted gutta is not so stable, however, as the gutta simply treated with water. Crude gutta percha, like balata, which was later introduced from Honduras and South America, contains varying percentages of resin (up to 50 per cent.), moisture and dirt, accidentally or purposely introduced. The pure gutta contains a hydrocarbon $(C_{10}H_{16})_n$ and resembles caoutchouc, but differs from it; it is hard at ordinary temperature, can be moulded at 90 deg. C., and melts at 150 deg.; it oxidises slowly in the light, not in the dark, and not in sea water, but the insulating power of different gutta perchas vary very much. Vulcanised gutta does not remain soft, but Dr. Pickles stated that he had, by curing for 8 hours (an exceptionally long period, of course), obtained vulcanised gutta like India rubber, and had, by treatment with hydrochloric acid, obtained evidence supporting the suggestion of Harries that pure caoutchouc and gutta are identical except, perhaps, as to molecular weight. Commercial gutta percha is mixed with rubber, which has, in recent years, more and more replaced it. The resins, the white crystalline albane and the yellow fluavil, are also being utilised, but speakers at the meeting put questions without giving information; one speaker mentioned that it was used for covering submarine fuses. Mr. Howson gave particulars also of his researches on the tensile strength and elongation of gutta perchas containing differential amounts of resins.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—The feeling of confidence in the future is still prevalent in the Scottish steel trade, but nothing of an appreciable nature has occurred to stimulate buying. Producers are however quite hopeful that the severe outside competition will ease off, and thus open up the way for the home material. The demand at present continues poor, and both ship plates and sections are rather dull. In the black sheet trade the conditions show little alteration and the heavier gauges are meeting with a very poor request. On the other hand, both the lighter gauges and galvanised sorts are active, but orders are gradually being cleared off and fresh bookings have not been so numerous of late. Inquiries are nevertheless on the increase, and makers are confident of securing some good business in the near future. The general export trade in steel material is still very poor. Prices continue steady and are as follow:—Boiler plates, 13*l.* per ton; ship plates, 9*l.* 15*s.* per ton; sections, 9*l.* 10*s.* per ton; and sheets, $\frac{1}{4}$-in. to $\frac{1}{2}$-in., 12*l.* per ton, all delivered Glasgow stations.

Malleable Iron Trade.—No change of any kind has taken place in the West of Scotland bar-iron trade during the past week. The current demand is very small, with the result that production is considerably curtailed. For re-rolled steel bars there is a fair outlet, but, all the same, the day-to-day demand is easier. "Crown" bars are unchanged at 12*l.* per ton delivered Glasgow stations.

Scottish Pig-Iron Trade.—The inquiry for Scottish pig-iron is again better but fresh bookings would hardly seem to be up to expectations yet, although the prospects of increased business are brighter. Meantime the output is much restricted all round. Prices show no change, but are firmer, and are as follow:—Hematite, 4*l.* 15*s.* per ton, delivered at the steel works; foundry iron, No. 1, 4*l.* 15*s.* per ton, and No. 3, 4*l.* 10*s.* per ton, both on trucks at makers' yards.

Scottish Pig-Iron Shipments.—The shipments of Scottish pig-iron from Glasgow Harbour for the week ended last Saturday, November 8, amounted to 667 tons. Of that total, 632 tons went to foreign destinations and only 35 tons went coastwise. For the corresponding week of last year the figures were 1,150 tons overseas and 194 tons coastwise, making a total shipment of 1,344 tons.

Clyde Shipbuilding.—An order has been secured by Messrs. William Denny and Bros., Dumbarton, to build a high-speed turbine steamer for the Dover service of the Southern Railway Company, London. This new vessel is to be ready for next year's summer service. She will mark an advance in type as compared with the vessels now in use.

THE NEW BELGIAN CUSTOMS TARIFF.—A translation of the new Belgian Customs Tariff, showing the rates of duty payable as from November 10 on British goods exported to Belgium, was published as a special supplement with the "Board of Trade Journal" on Thursday of this week.

THE AUSTRALIAN TRANSCONTINENTAL RAILWAY.—Agreement is announced between the Government of South Australia and the Commonwealth Government in reference to the construction of a section of the North-South Transcontinental Railway. The section will extend from the present terminus at Oodnadatta in South Australia to Alice Springs in the Northern Territory.

NEW THAMES BRIDGES.—The question of the construction of a number of new bridges on the upper reaches of the Thames has been before the Surrey County Council. They are the subject of negotiations between the Council and the Ministry of Transport. Among them are a proposed bridge which would form part of the Chertsey arterial road, and new bridges at Richmond and Hampton Court. In these latter cases it is proposed that the new structures should relieve, but not supersede, existing bridges.

TRADE UNION REGULATIONS AND INDUSTRIAL OUTPUT.—It is announced that out of the funds of the Peter Le Neve Foster Trust the Council of the Royal Society of Arts are offering a prize of £25 for an essay on "The Effects of Trade Union Regulations on Industrial Output." Intending competitors must send in their contributions not later than March 31, 1925, to the Secretary of the Royal Society of Arts, John-street, Adelphi, London, W.C.2, from whom all particulars may be obtained.

AUTOMATIC SUB-STATIONS.—The reliability of automatic sub-stations has been very thoroughly demonstrated in the United States, where the first equipment was installed about 10 years ago, and the number now in service totals several hundreds. In Great Britain the automatic operation of sub-stations is a much more recent development but is receiving rapidly increasing attention. As an indication of this it may be stated that the British Thomson-Houston Company, Limited, Rugby, has manufactured, or has on order, 41 automatic sub-station equipments totalling nearly 72,000 kw., for use in this country and overseas. The machines are either rotary converters or synchronous motor-generator sets, according to the conditions to be fulfilled, and operate on supply frequencies of 25 to 50 cycles, giving output pressures from 400 to 3,000 volts D.C. These automatic sub-station plants are being used for traction, power or mixed power and lighting loads.

NOTICES OF MEETINGS.

THE INSTITUTION OF MECHANICAL ENGINEERS.—To-night, at 7 p.m., at Storey's-gate, S.W.1. Informal Meeting. "Driving Belts and Ropes." Introduced by Mr. D. N. Hunt. Friday, November 21, at 6 p.m. General Meeting. "First Report of the Marine Oil-Engine Trials Committee."

THE JUNIOR INSTITUTION OF ENGINEERS.—To-night, at 7 p.m., at 39, Victoria-street, S.W. 1. Annual General Meeting. Friday, November 21, at 7.30 p.m., Lecturette, "Stainless Steel," by Mr. J. G. Hopcraft.

THE INSTITUTE OF BRITISH FOUNDRYMEN, BIRMINGHAM BRANCH.—Saturday, November 15, at the Technical College, Dudley. "Aluminium Castings," by Mr. C. Dicken.

THE HULL ASSOCIATION OF ENGINEERS.—Saturday, November 15, at 7.15 p.m., at the Municipal Technical College, Park-street, Hull. Lecture, "Case Hardening," by Mr. P. B. Henshaw.

THE NORTHAMPTON ENGINEERING COLLEGE ENGINEERING SOCIETY.—Monday, November 17, at 5.30 p.m., at St. John-street, E.C. 1. "The Mechanical Transmission of Power on Electric Locomotives with Special Reference to Individual Axle Drive," by Mr. V. F. Cornish.

THE BRITISH COLD STORAGE AND ICE ASSOCIATION.—Monday, November 17, at 5.30 p.m., at the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Recent Developments in Refrigeration Research," by Dr. E. Griffiths.

THE INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES SECTION.—Monday, November 17, at 7 p.m., at Storey's-gate, S.W. 1. Lecture, "The Production of a Modern Technical Journal," by Loughnan Pendred.

THE BRADFORD ENGINEERING SOCIETY.—Monday, November 17, at 7.30 p.m., at the Bradford Technical College. Lecture, "High Lift Turbine Pumps," by Mr. R. Pennington, B.Sc.

THE SOCIETY OF CHEMICAL INDUSTRY.—Monday, November 17, at 8 p.m., at the Engineers' Club, Coventry-street, W. 1. Joint meeting with the Institution of the Rubber Industry. "Latex, its Chemistry and the Development of its Industrial Applications," by Dr. A. Van Rossem.

THE FARADAY SOCIETY.—Monday, November 17, at 8 p.m., at the Chemical Society, Burlington House, Piccadilly, W.1. "The Hydrolysis of Alkali Cyanides in Aqueous Solution," by Messrs. R. W. E. B. Harman and F. P. Worley. "Note on the Expansion of Water while Freezing," by Mr. A. P. Laurie. "The Viscosity of Reversible Emulsions," by Mr. S. S. Joshi. "On the Viscosities of Liquids at their Boiling Points," by Mr. D. B. MacLeod. "The Kinetic Theory of Evaporation," by Mr. D. B. MacLeod. "New Design for Apparatus to Measure the Coefficient of Deviation from Boyle's Law, and the Determination of this Coefficient for Acetylene," by Messrs. J. T. Howarth and F. G. Burt. Exhibition of Physico-Chemical Apparatus by Messrs. A. Gallenkamp and Co., Limited.

THE INSTITUTE OF TRANSPORT.—Tuesday, November 18, at 5.30 p.m., at the Institution of Electrical Engineers, Victoria-embankment, W.C. 2. Lecture: "The Accountancy of a Trust Port from a Managerial Point of View," by Mr. C. E. Baldwin.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, November 18, at 6 p.m., at Great George-street, S.W.1. Ordinary Meeting. Paper to be submitted for discussion: "Notes on Modern Practice in Road-making," by Mr. Walton John Hadfield, M.Inst.C.E.

THE INSTITUTE OF MARINE ENGINEERS.—Tuesday, November 18, at 6.30 p.m., at 85-88, The Minories, Tower-hill, E.1. "The Influence of Internal-Combustion Engines on the Design of Merchant Ships," by Mr. J. McGovern.

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Tuesday, November 18, at 7.30 p.m., at the Rankine Hall, 39, Elmbank-crescent, Glasgow. Discussion on "A Proposed Form of Bow Construction," by Mr. E. F. Spanner. Paper, "A New Electric Drive for Ship and Other Auxiliaries," by Mr. Gilbert Austin, will be read.

THE ILLUMINATING ENGINEERING SOCIETY.—Tuesday, November 18, at 8 p.m., at the Royal Society of Arts, John-street, Adelphi, W.C. 2. Opening Meeting.

THE MIDLAND INSTITUTE OF MINING ENGINEERS.—Wednesday, November 19, at 2.30 p.m., at the University, Leeds. "The Utilisation of Waste Heat and Surplus Gas from Coke Ovens," by Mr. I. C. F. Statham, B.Eng. Discussion on "The Collieries of the First Danube Steam Navigation Company (D.D.S.G.), Nr. Pécs (Funfkirchen), Hungary," by Dr. J. Herczegh.

THE SOCIETY OF GLASS TECHNOLOGY. Wednesday, November 19, at 3 p.m., at the University, Leeds. "A Note on the Glass Houses of the Leeds District, in the 17th, 18th and the early 19th Centuries," by Mr. Francis Buckley. "A Striking Instance of Fireclay Corrosion through the Action of Saltcake," by Prof. W. E. S. Turner, D.Sc. "A Note on Some Properties of a Sandstone Block after Use in a Glass Furnace," by Mr. H. S. Houldsworth, M.Sc. "The Production of Colourless Glass in Tank Furnaces, with Special Reference to the Use of Selenium, Part IV. The Influence of Arsenious Oxide," by Mr. A. Cousen, M.Sc., and Prof. W. E. S. Turner, D.Sc.

THE BRITISH CAST-IRON RESEARCH ASSOCIATION.—Wednesday, November 19, at 3.30 p.m., at the Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Fourth Annual Meeting.

THE ROYAL METEOROLOGICAL SOCIETY.—Wednesday, November 19, at 5 p.m., at 49, Cromwell-road, South Kensington, S.W.7. "Note on Bjerknes's Contribution of 1921 to the Mechanics of the General Circulation," by Sir Gilbert Walker, C.S.I., F.R.S. "The Correlation between Pressure and Temperature in the Upper Air, with a Suggested Explanation," by W. H. Dines, F.R.S.

THE ROYAL SOCIETY OF ARTS.—Wednesday, November 19, at 8 p.m., at John-street, Adelphi, W.C.2. "The Scientific Principles of Artificial Incubation," by Mr. Llewelyn B. Atkinson, M.I.E.E.

THE INSTITUTION OF MINING AND METALLURGY.—Thursday, November 20, at 5.30 p.m., at the Geological Society, Burlington House, Piccadilly, W.1. "Treatment of Gold-bearing Quartz of the Kolar Gold Field," by Messrs. R. H. Kendall and A. F. Hosking. "'Protective Alkalinity,' and the Use of Alkali, in Cyanidation," by Mr. J. R. H. Robertson.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, November 20, at 6 p.m., at Victoria-embankment, W.C.2. "Automatic and Semi-automatic Mercury-Vapour Rectifier Sub-stations," by Mr. G. Rogers.

THE JUNIOR INSTITUTION OF ENGINEERS, NORTH-WESTERN SECTION.—Friday, November 21, at 7.30 p.m., at the Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester. Lecture—"Powdered Fuel," by Mr. Geo. E. Blythe.

THE INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Friday, November 21, at 7.30 p.m. Conjoint Meeting of Societies at the Sheffield Metallurgical Association's Rooms, 198, West-street, Sheffield. "Non-Ferrous Metals in the Foundry," by Mr. A. Marks.

THE INSTITUTION OF PRODUCTION ENGINEERS.—Friday, November 21, at 7.30 p.m., at the Engineers' Club, Coventry-street, W. 1. "Gear Cutting, with Special Reference to the 'Sykes' Generating System," by Mr. O. H. Medcalfe.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—The most important development in the coal trade during the past week has been the news of an attempted coup by the Germans to secure a monopoly in Portugal. Fortunately, the endeavour has been frustrated, but the possibility of the Germans increasing their shipments to that country is still acute. It is learned that, taking advantage of the Dawes agreement, the Germans offered to supply the Portuguese navy, arsenals and railways with coal over a number of years on terms which were agreed in principle by the Portuguese Government. Representations were, however, made through the British Foreign Office on the matter, and it is understood that as a result of this the German coup has failed. It is, however, known that the Germans are still endeavouring to create a market for their coals in Portugal, for it is proposed to form a company at Lisbon for the purpose of bunkering vessels and supplying factories with German coal. Agents have offered supplies with credits of six months, and the seriousness of this to the Welsh coal trade will be appreciated when it is mentioned that the South Wales collieries sell to shippers on a seven days' credit, while the shippers usually give their customers a thirty days' credit, so that to compete with the Germans an extra credit will have to be given. It is also understood that the requirements of the Portuguese Government, navy and arsenals are to be put out to tender, but that the Germans intend offering supplies on a ninety days' credit basis. Meanwhile, the Welsh coal trade has not shown any material alteration during the past week. Best steam smalls, best dry large and sized coals are in moderate request at recent prices, but all other grades are in excess of the demand despite a continued restriction in outputs due to frequent and numerous pit stoppages. Best Admiralty large coal is obtainable at 27*s.*, with seconds from 25*s.* to 26*s.* and ordinarys from 24*s.* 6*d.* to 25*s.* Monmouthshire large coals range from 23*s.* 6*d.* to 24*s.* 6*d.*, while smalls rule from 10*s.* to 16*s.*, according to quality. Exports of coal as cargo in October amounted to only 1,960,150 tons, compared with 2,056,800 tons in September. The October total was only less in one month of the year, while the shipments per working day amounted to only 72,600 tons, compared with 79,100 tons in September. Exports were reduced to all countries, with the exception of Spain, Holland, Germany, Belgium and South America, in which cases only small increases were noted. Compared with October of last year, the shipments in the past month showed a reduction of 644,400 tons.

Iron and Steel.—Exports of iron and steel goods from the South Wales ports in the past week amounted to 6,040 tons, compared with 11,410 tons a week earlier. Shipments of tinplates and terneplates totalled 3,982 tons, compared with 6,110 tons; black plates and sheets to 912 tons against 1,626 tons; galvanised sheets to 809 tons against 2,555 tons; and other iron and steel goods to 339 tons to 1,117 tons.

SILVER MINES OF CANADA.—It is just twenty years since the Cobalt silver mines were discovered in Ontario, Canada. Last year Cobalt produced over 10,700,000 ounces of silver. Only three camps in the world have produced more silver than Cobalt. The camps are Potosi, Bolivia, 30,000 tons, producing since 1545; Guanajuato, Mexico, 15,000 tons, since 1558; Zacatecas, Mexico, 14,000 tons, produced between 1548 and 1832. Cobalt comes next with 10,000 tons since 1904.

THE PENANG HILLS RAILWAY.

CONSTRUCTED BY THE FEDERATED MALAY STATES RAILWAYS; MR. A. R. JOHNSON, A.M.I.MECH.E., ENGINEER.

(*For Description, see Page* 664.)

FIG. 34. VIEW AT SITE OF PART OF UPPER SECTION.

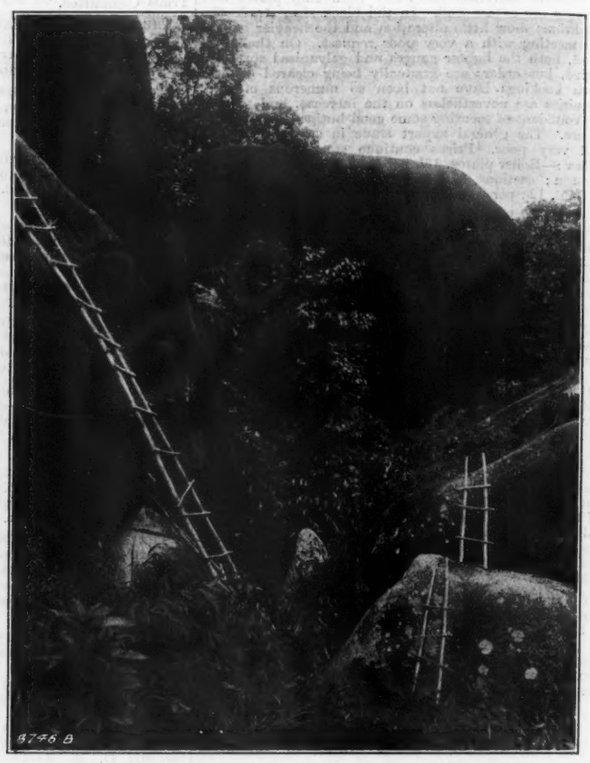


FIG. 35. SITE OF THE 40-FT. ARCHES ON THE LOWER SECTION.

FIG. 36. EARLY STAGE OF VIADUCT CONSTRUCTION, MARKS 659 TO 823, UPPER SECTION.

FIG. 37. WOOD FORMS FOR VIADUCT ARCHES, MARKS 1,965 TO 2,129, LOWER SECTION.

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CONSTRUCTED BY THE FEDERATED MALAY STATES RAILWAYS; MR. A. R. JOHNSON, A.M.I.MECH.E., ENGINEER.

(*For Description, see Page* 664.)

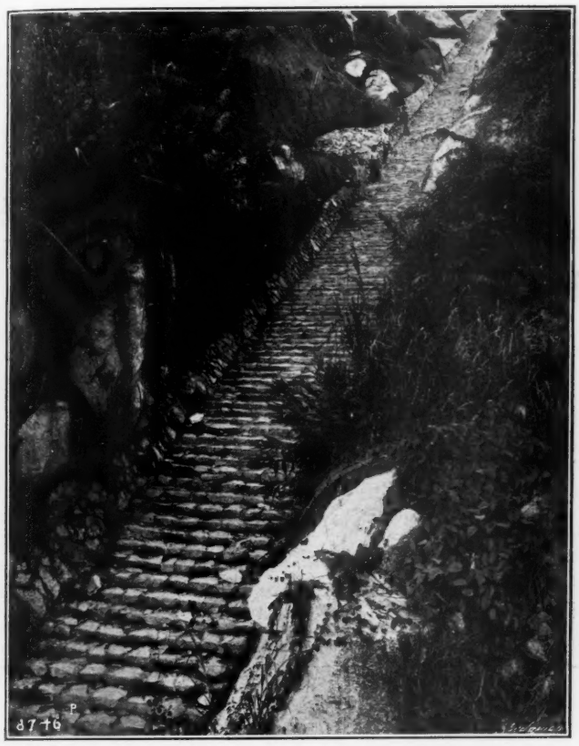

FIG. 11. CUTTING ON LOWER SECTION.

FIG. 12. CUTTING ON UPPER SECTION, WITH TEMPORARY HAULAGE TRACK.

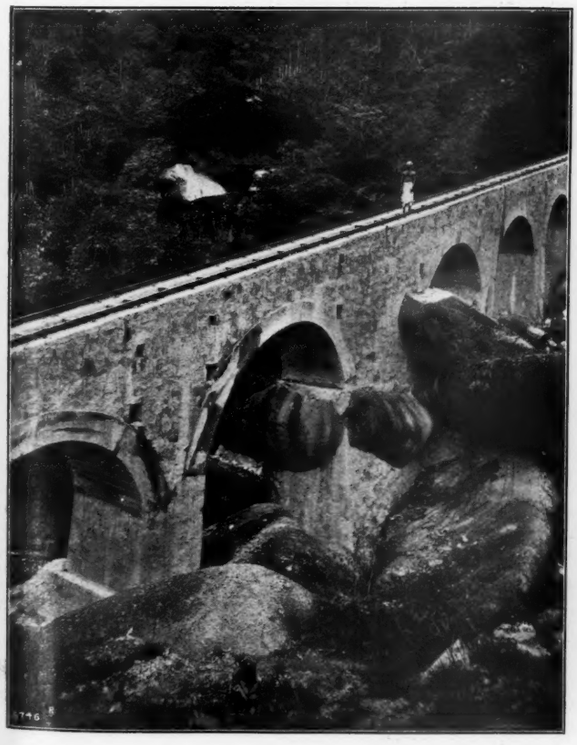

FIG. 13. VIADUCT ON UPPER SECTION, LOOKING UP HILL.

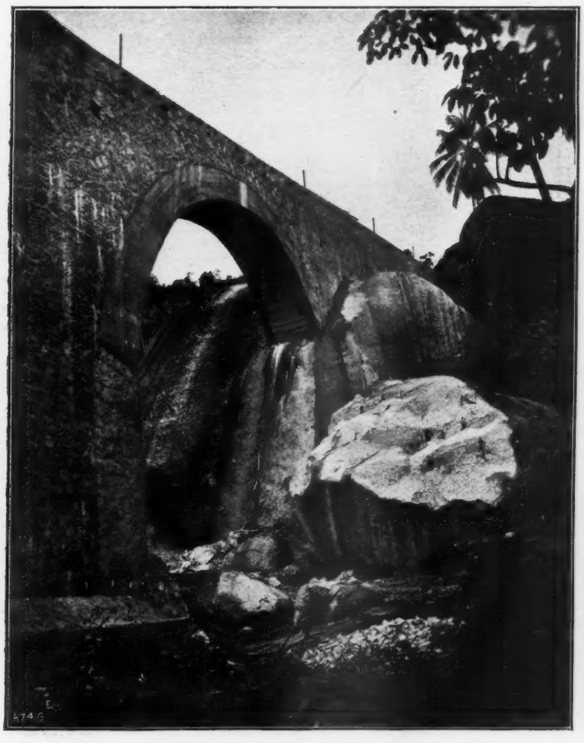

FIG. 14. 40-FT. ARCH ON LOWER SECTION, LOOKING UP HILL.

(*To face page* 666.)

THE PENANG HILLS RAILWAY.

CONSTRUCTED BY THE FEDERATED MALAY STATES RAILWAYS; MR. A. R. JOHNSON, A.M.I.MECH.E., ENGINEER.

(*For Description see Page* 664.)

FIG. 15. PIERS FOR VIADUCT. MARK 2,463, UPPER SECTION.

FIG. 16. CENTRING FOR 40-FT. ARCH, LOWER SECTION.

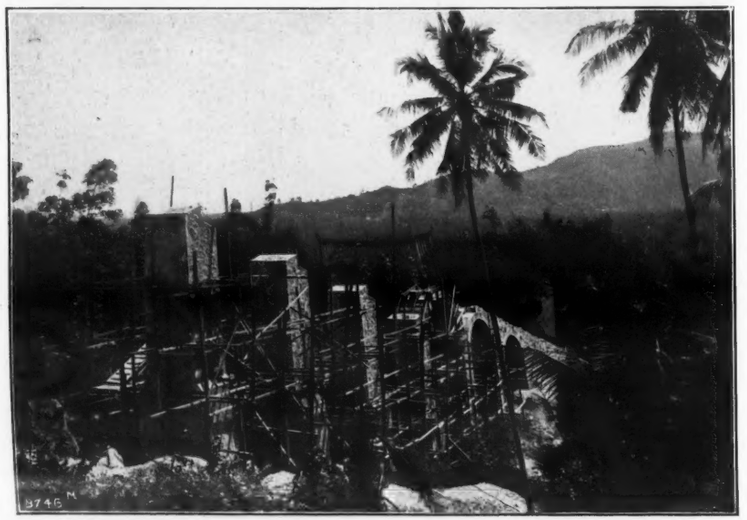

FIG. 17. VIADUCT AT MARK 653 UNDER CONSTRUCTION, LOWER SECTION.

FIG. 18. VIADUCT AT MARK 981 UNDER CONSTRUCTION, LOWER SECTION.

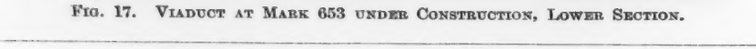

Fig. 17. Viaduct at Mark 653 under Construction, Lower Section.

Fig. 18. Viaduct at Mark 981 under Construction, Lower Section.

THE PENANG HILLS RAILWAY.

CONSTRUCTED BY THE FEDERATED MALAY STATES RAILWAYS; MR. A. R. JOHNSON, A.M.I.MECH.E., ENGINEER.

(*For Description, see Page* 664.)

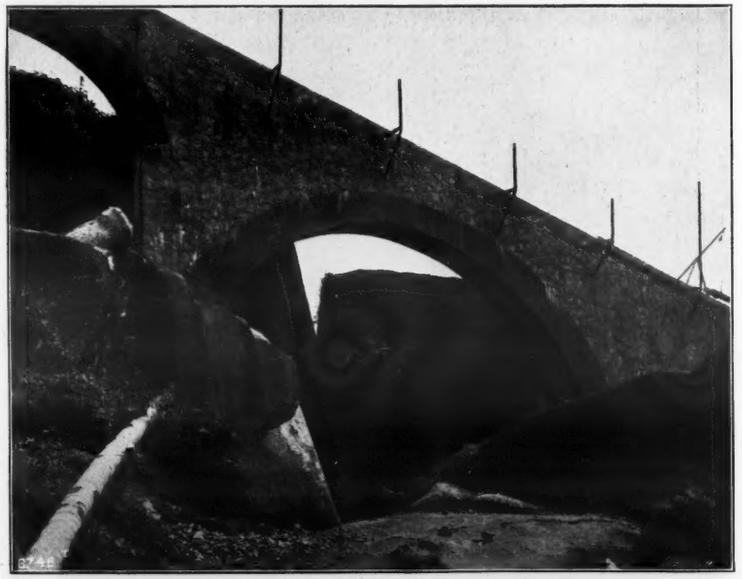

Fig. 19. 40-Ft. Arch at Mark 817, Lower Section.

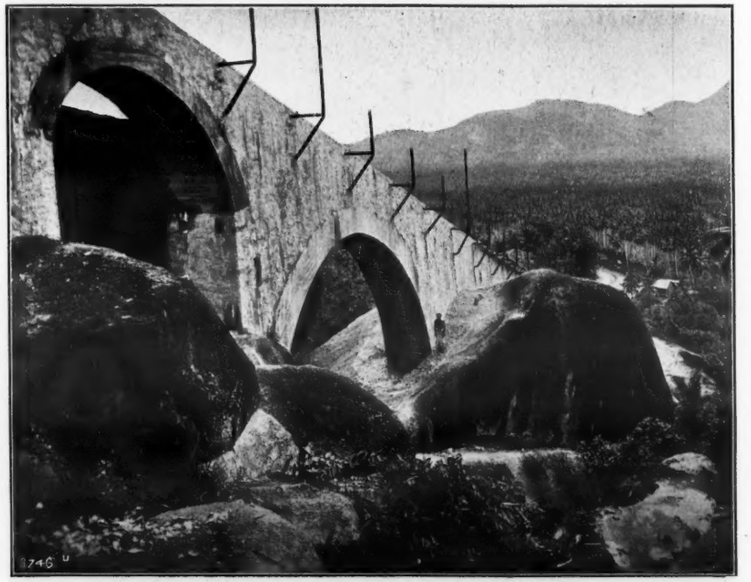

Fig. 20. 40-Ft. Arch at Mark 817, Lower Section.

Fig. 21. Viaduct between Marks 1,965 and 2,129, Lower Section.

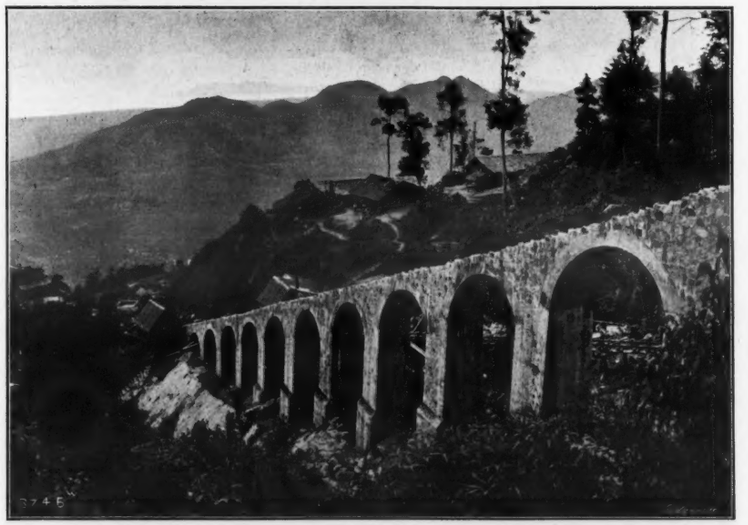

Fig. 22. Viaduct between Marks 2,463 and 2,135, Upper Section.

THE PENANG HILLS RAILWAY.

CONSTRUCTED BY THE FEDERATED MALAY STATES RAILWAYS; MR. A. R. JOHNSON, A.M.I.MECH.E., ENGINEER.

(*For Description, see Page* 664.)

FIG. 23. UPPER FACE OF TUNNEL COMPLETED.

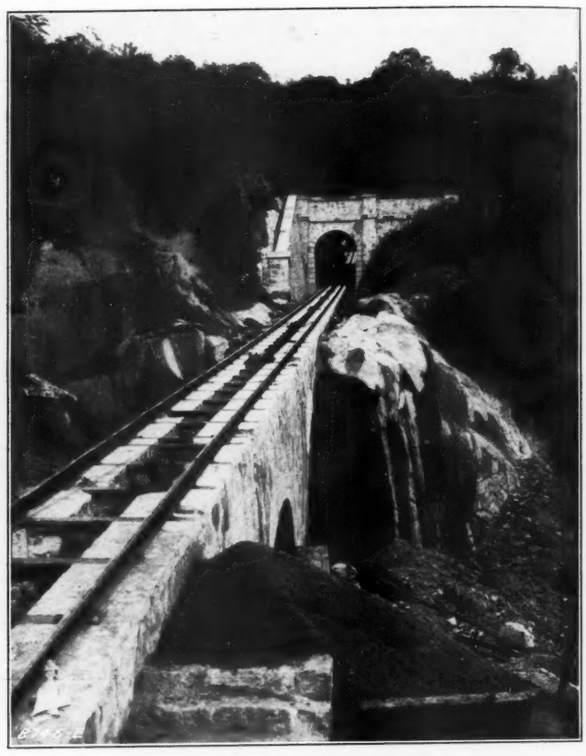

FIG. 24. LOWER FACE OF TUNNEL COMPLETED

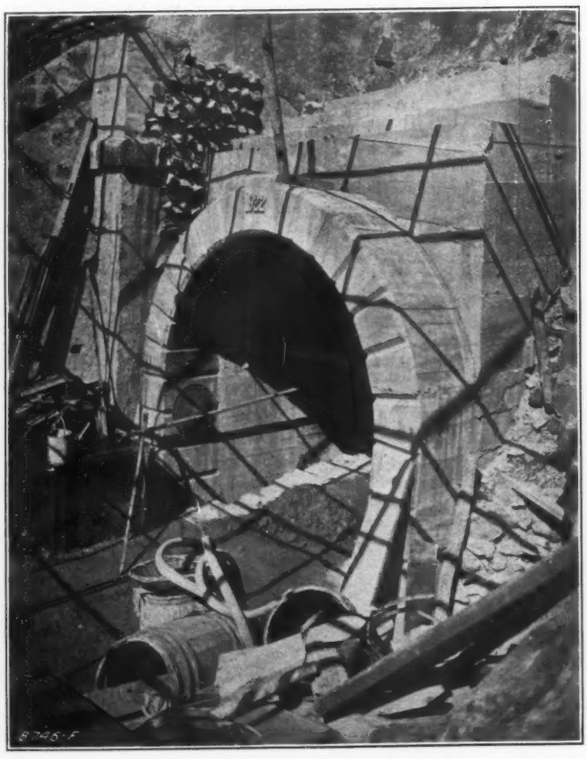

FIG. 25. LOWER FACE OF TUNNEL DURING CONSTRUCTION.

FIG. 26. VIEW FROM INSIDE OF TUNNEL LOOKING DOWN HILL.

(*To face page* 667.)

ENGINEERING.

Offices for Publication and Advertisements, 35 and 36, Bedford Street, Strand, London, W.C.2.

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ENGINEERING.

FRIDAY, NOVEMBER 14, 1924.

THE PHYSICS OF INTERNAL-COMBUSTION ENGINES.

IN one of his many captivating and singularly lucid addresses on scientific subjects, Sir J. J. Thomson observed that in random researches, that is to say, in investigations unguided by some mental picture of the mechanism involved, the progress made will, from the mathematical theory of probability, be generally in proportion only to the square root of the effort expended. Unfortunately the engineer is in many cases compelled to design his structures and construct his engines with exceedingly little assistance from theory, and his experimenting has accordingly had to be more or less of the random variety. The procedure has no doubt been fully as uneconomical as the theory above mentioned would indicate, but no alternative has commonly been possible, and the engineer may fairly claim credit for excellent work done under extremely difficult conditions.

No doubt in many cases, had he awaited the completion of "fundamental researches" money might have be saved, but time would certainly have been lost, and the community could not wait for its steam engines and its gas engines, its bridges and its ships until the results of "fundamental researches" were available. Moreover, it is impossible at the outset to say whether or no any proposed research will prove of fundamental importance. Indeed it quite commonly happens that the investigations, which give us the clearest idea as to the intimate character of the phenomena with which the engineer has to deal, have been pursued solely to gratify the experimenter's curiosity, and without any suspicion that the observations made, might prove of great industrial and commercial importance, whilst other researches involving a large expenditure of time and money, and made with the direct object of elucidating certain practical problems, may utterly fail in their aim.

The pioneers of the gas-engine for the most part concerned themselves but little with detailed speculations as to what was actually occurring inside the cylinders of their engines, and so far as they did do so, they often held wildly inaccurate views. In one important patent case, for example, great advantages were claimed for the stratification of the charge, whereas to-day it is conceded that turbulence inside the cylinder should be promoted rather than be checked. Nevertheless, in spite of false or imperfect theories, engineers succeeded by a process of cut and try in producing satisfactory gas engines, which subsequent investigations have proved to be even more efficient utilisers of the available energy than their designers believed.

In view of these considerations we are inclined to suspect that certain of those present at the recent discussions in London and Manchester of Professor David's papers at the Institution of Mechanical Engineers, must have been tempted to dismiss the debate as of academic interest, and to question whether the labour and ingenuity expended in laboratory experiments will lead to any material improvement in the efficiency of internal-combustion engines. It is quite possible that this pessimistic forecaste may prove justified, but most of us like not merely to know that a certain procedure leads to certain effects, but also to be able to trace out, more or less adequately, the details of the phenomena involved.

When the joint discussion on gaseous explosions, by the Engineering and Chemical Sections of the British Association took place at Leicester in 1907, theory and experiment had advanced far enough to establish the result that the maximum pressures recorded in such explosions were not much more than one-half of what the then existing state of knowledge would have led us to expect. There seemed, therefore, a promising possibility of effecting a great improvement in gas-engine performance, by making a thorough investigation into the reasons for the defect of pressure. Unfortunately, the hope has failed, but it is no small gain to know what the limitations really are, and to have learnt that, given the actual properties of the explosive mixtures used, we were already obtaining fully 80 per cent. of the efficiency theoretically possible.

Most of the defect of pressure is now accounted for by the large increase in the specific heat of the products of combustion with rising temperatures, and for the rest we have on the one hand Professor Bone's suggestion that the still outstanding deficit is due to a temporary failure of the law by which molecular energy is equally distributed between the energy of translation, the energy of rotation, and what he calls the vibratory energy of the molecule. On the other hand, Professor David attributes the defect to delayed combustion, and Mr. Pye to dissociation, but here it seems at least possible that the two are really one and the same thing.

In this connection, Mr. Pye quoted figures, which we believe, are due to Langen, as to the dissociation of CO_2 at different temperatures. Langen's experiments showed that at 1,123 deg. C., the dissociation of this gas amounted to 0·004 per cent., at 1,970 deg. C. to 4·5 per cent., and at 2,623 deg. C. to 37 per cent. These experiments were not made under gas-engine conditions, and the fundamental change in our views as to the causes of dissociation, which has been advocated by Sir J. J. Thomson, by Professor Perrin, and by certain other investigators, makes it at least possible that the figures recorded may have little or no bearing upon the amount of dissociation produced in a gaseous explosion. We used to be taught that dissociation was caused by molecular collisions, but this view is incompatible with the facts of observation, which show that when a gas is dissociated, the proportion transformed per second depends entirely on the temperature and not at all on the pressure or "concentration" of the gas. Professor Perrin maintains* accordingly "that the essential mechanism of all chemical reaction is therefore to be sought in the action of light on atoms." Support for this view may also be drawn from the fact that a mixture of hydrogen and chlorine is perfectly stable if kept in the dark, but if exposed to diffuse daylight, combination occurs with the production

* Atoms by Jean Perrin. 2nd Edition. Constable and Co., Limited, page 164.

of hydrochloric acid. There seems no reason whatever for differentiating between this particular chemical reaction and any other, and since radiation obviously plays an all-important part here, it is a fair inference that it is, as Professor Perrin claims, responsible for initiating all chemical reactions, and in the case of dissociation it appears to be the sole effective cause.

If this be the case, and dissociation is due entirely to light quanta, and not to molecular collisions, it is evident that there must be considerable risk of error in applying Langen's results on the connection between temperature and dissociation to gas-engine conditions. In a letter published on page 641 of last week's issue, Professor David states that his experiments indicate that the density of the radiation in a gas-engine cylinder is insufficient to augment materially the normal dissociation. It would seem, however, quite possible that when active combustion is in progress the density of the radiation may be exceedingly great in the immediate vicinity of reacting molecules. In fact, Faraday's experiment, in which he proved that platinum could be melted in a candle flame, seems to afford a demonstration that this must be the case. It does not seem safe, therefore, to extend to mixtures in the act of chemical combination deductions drawn from experiments made after the reaction has ceased. It is only when phenomena can be represented by a linear law that an average can be taken as a fair representation of the actual facts. We do not know the details of Professor David's experiments, but the above considerations do indicate what would seem to be very formidable difficulties in securing decisive results. As yet very little is known as to the mechanism of dissociation, and it can not be denied that the absorption of radiation by a molecule is not necessarily or indeed commonly followed by dissociation, and it may be that the process has to be effected in steps, and only takes place when the electron system, having been disturbed by the absorption of one radiation quantum, receives an additional shock before the effects of the first have been dissipated.

The radiation in a gas engine cylinder or indeed in any flame being highly selective and very intense near the reacting molecules, it seems exceedingly probable that the dissociation produced may be much greater than would be inferred from the average temperature attained. It is, of course, quite true, as Sir Dugald Clerk pointed out, that flames are remarkably transparent to their own radiations, but it has to be remembered that they are still more transparent to light of other wave lengths. The process by which radiation is absorbed by a gas apparently demands a nice adjustment between the momentary positions of the electrons in the molecule and the orientation and energy of the light quantum traversing it. Hence quite a thick layer of gas is required to entrap any material proportion of even the most absorbable rays. Pressure facilitates chemical combination, since molecules cannot combine unless they come into actual contact, and the number of collisions made per second is, other things being equal, increased by a rise in pressure. On the other hand in normal conditions the rate of dissociation is independent of the pressure, so that if "after burning" and "dissociation" are merely different aspects of the same phenomenon it would be anticipated that the effects would be less marked the higher the pressure.

With respect to Professor Bone's suggestion that the observed defect of pressure is in part due to an abnormal partition of the energy between the vibratory, rotatory, and translatory forms, it is difficult to believe that this can be well founded, if by his vibratory energy is meant some mechanical vibration. Each molecule makes a colossal number of collisions* per second, and were all its forms of energy mechanical it seems certain that the time required to secure an equi-partition of the energy would be vanishingly small. This belief receives support from the agreement of the velocity of sound with theory. In the case of some shrill notes the changes of pressure may follow each other at the rate of some 40,000 per second, and unless there were equalisation between the translatory and rotational energies such waves should give an abnormal velocity for the speed of sound. In the 9th Edition of the *Encyclopedia Britannica*, moreover, Burbury and Watson have given a calculation which indicates that an abnormal distribution of translatory energies would be annulled in $\frac{1}{60,000,000}$ of a second, and is hardly conceivable that the time taken to equalise abnormal partitions of the energies of rotation and of mechanical vibration shall be of an entirely different order of magnitude. If this be so, it seems impossible that the observed defect of pressure in gaseous explosions can be explained in the way suggested by Professor Bone.

It is, however, possible and indeed probable that the act of chemical combination is accompanied by a displacement of electrons into temporarily stable positions, and whilst they remain in these they will represent potential energy stored up in the combining molecules which will be radiated out when the electrons fall back into permanently stable positions. By making use of Planck's formula for the energy associated with particular wave lengths, Mr. A. Melencovitch, in a letter published on page 176 of our issue of August 10, 1923, has calculated that the quantum of energy associated with each characteristic ray emitted during the process of the combination of hydrogen and oxygen to form a molecule of water is equal to about 18 per cent. of the total heat produced by the combination. A similar amount of potential energy would be represented by each electron displaced to a temporarily stable position as suggested above.

Professor Bone also laid stress on the importance of working with pure materials. On the other hand, however, in his lecture to the Royal Institution on May 11, 1923, he demonstrated very clearly that the use of pure materials might lead to extremely erroneous conclusions as to the behaviour of mixtures. For example, he showed that when pure CO was mixed with pure oxygen and pure nitrogen, these gases being in "atmospheric" proportions, the process of combustion was slow, whilst if a little hydrogen were also added the combustion was extremely rapid. Hence an engineer who wished to determine the behaviour in an engine of blast furnace gas, might, it would seem, be greatly misled if he experimented with pure CO and pure air. Such a result seems to justify engineers in conducting their experiments with the fuels and mixtures they have to use in practical work.

* In Kaye and Laby's Physical and Chemical Constants it is stated that at normal temperature and pressure a molecule of oxygen makes 5×10^9 collisions per second.

THE CULTIVATION OF FOREIGN TRADE.

Before the War those who tried to do business in foreign countries had often to notice that German firms received much more help from their diplomatic and consular service than did English firms from ours. It might also have been said equally that German firms showed a much greater disposition to invoke and to profit by such assistance. The present position is somewhat better. The Department of Overseas Trade is directing its activities towards establishing a more efficient mechanism for taking care of the interests of British industry in foreign markets. Such measures, however, can be successful only if they are accompanied by corresponding efforts on the part of the industries to be benefitted. Plainly, it must be in the last degree disheartening to zealous officers to find their best energies spent on accumulating information that is consistently ignored. But that is the least of the drawbacks. The extent to which the Government can continue to provide information must ultimately bear some sort of proportion to the extent to which the industries it is desired to benefit are found to profit by them, and the less use is made of such information, the less information will be provided. Those, again, who are trying to discharge their duty as forward observation officers in commercial matters are working at a notable disadvantage in formulating to themselves subjects of their enquiries if the applications of the industries with which they are concerned do not keep them in constant touch with the actual requirements of those industries; a contact that can only be established and maintained if the industries are as keen on taking advantage of the services placed at their disposal as the officers are to render those services intelligently. On the other hand, the more use is made of the information, the more the Government will be encouraged to strengthen the force by which it is obtained.

General reflections such as these are unfortunately not new. They were often made while British trade facilities in foreign countries were worse than they are now; and it is to be feared that some manufacturers who desire export trade do not even yet realise both what they must do to get it, and what assistance they can obtain from the Overseas Trade Department. In the valuable series of reports on the economic conditions of various foreign countries which the Department has been producing for some time, two recent reports, relating respectively to Turkey and Colombia, incidentally tend to confirm this apprehension.*

Neither of these countries is at present of the first commercial importance, but each of them is at a criticial epoch of its industrial history, and its position both as a consumer of commodities and a producer of material is likely to increase, until in both respects it arrives at a position commensurate with its natural resources. The value of the start that a manufacturer desiring business in such countries can obtain at such an epoch must be measured, therefore, not on the present trade of the country but on the amount that it is likely to attain.

For the moment undoubtedly, Turkey has by no means recovered from the disorganisation due to the events of the war. It is estimated that her present purchasing power is little more than half what it was when the war began, and the Report under notice recommends certain precautions in granting credit on new accounts. Nevertheless, there can be no doubt that ultimately the experimental legislation and administration that has been adopted tentatively by the Turkish authorities must steady down to a settled policy, reflecting the undoubted intelligence and ability of those who are behind it, and the development of the resources of this extremely rich country will make it more a considerable factor in international trade. In the rich and as yet imperfectly developed interior, it is expected that there will soon be a good market for the sale of agricultural machinery, which is admitted duty free; and already foreign firms, particularly American and Czecho-Slovakian, are endeavouring to establish themselves in the trade. To do so the Report regards it as necessary that credit or hire purchase arrangements should be instituted, that transport agreements should be made with the railways for the distribution of machinery, such as tractors, along their lines, and in particular that repair stations should be erected at sufficient intervals, with a good range of spare parts and an adequate technical staff able both to demonstrate and to give advice. Great stress is laid on the importance in respect to any class of manufactured goods of satisfying the purchaser that spare parts will be readily available, and of providing designs that will be cheap, strong, simple and light. The Report urges, moreover, that British manufacturers will find it increasingly difficult to enter the market unless they take active steps to investigate local requirements and possibilities personally.

Another line in which considerable business is expected to be placed within the next five years is for railway material, both locomotive and other rolling-stock and permanent way; for although the Government has not yet decided whether it will administer the Anatolian railway system as a State Railway, or hand it back to private exploitation, it is quite certain that both the rolling-stock and the permanent way are in urgent need of repairs and renovation. German firms are already displaying great activity in the matter, and it is thought that if British firms do not keep in close touch with the Government administration, the

* Report on the Economic and Commercial Conditions in Turkey, April, 1924. By Colonel H. Woods, O.B.E., Commercial Secretary, Constantinople. H.M. Stationery Office. [1s. 6d. net.]

Report on the Economic Conditions in the Republic of Colombia, March, 1924. By Mr. C. C. H. Lee, British Vice-Consul, Bogota. H.M. Stationery Office. [1s. net.]

business will be altogether lost. It will be remembered that the pre-war rolling-stock was German, and it is quite likely that the material for some of the new lines will also be required to conform to German specifications. Another line, again, in which as yet this country is said to be almost unrepresented is motor transport. Cars for Turkey require to fulfil special conditions, and at the moment there is scarcely an English firm represented in the long list of makers of the cars now circulating in Constantinople. This is the more to be regretted because on the one hand great districts of the country are not served by railways and must, therefore, be dependent on motor transport, and on the other hand the improvement in the construction and upkeep of roads, which is an evident necessity, will give a considerable stimulus to the demand for motor transport. This, however, will be satisfied by those countries whose manufacturers have made their designs to conform to local needs, their arrangements to assure the prompt supply of spares, and their propaganda to be understood by their customers and expressed in their language.

Colombia is another country of which most of the development has yet to be made. Though it is about five times as large as Great Britain, and has great agricultural advantages as well as mineral deposits, the United States Financial Commission, which at the invitation of the Colombia Government visited the country last year, found that not half its resources had been touched. The purpose of the visit of this Commission was not primarily to appreciate the resources of the country, but to make suggestions for re-organising its finances, a re-organisation that was thought to be the more necessary because of the windfall of 25 million American dollars that it had received in respect of the Panama Award. The Government has taken the advice of the Commission very seriously, and it is expected that the active measures to support the credit of the country and place its finances in proper order will have the desired result. For the moment there is some trade depression, but debt is being paid off, and the situation is likely to improve. The present report points out, however, that British shippers should satisfy themselves with particular care of the stability of their consignees. The Government itself is likely to be in the market in particular for railway and other transport plant; for in spite of the total size of the country its railway mileage is said to be much less than that of the small state of Connecticut. With these contracts, the further caution is given that they should be drawn up and worded with great care, so as to avoid all possible misunderstandings.

In regard to the general trade of the country, which at present is largely in the hands of North American and German firms, the Report regards the extra cost of freight from Great Britain as not being an insuperable obstacle, especially for heavy machinery and public works material, in which superior workmanship and durability more than offset the somewhat higher cost. It lays stress, however, on the fact that whereas North American firms usually have a representative on the spot to vouch for the excellence of their wares, British manufacturers neglect this precaution. It is said that the United States has no special advantage in respect to obtaining the goodwill of Colombian buyers, and that there should be no difficulty in acquiring a larger proportion of the Colombian market than this country enjoys at present if suitable efforts are made. An incidental caution is given against appointing a particular individual or firm as sole agent for Colombia, in view of difficulties of communication and diversity of conditions in different parts of the country.

CLASS WARFARE TALK.

There have been in this country, and there are still men, many of whom have started from the lowest rung of the ladder and have acquired true nobility by reason of their talents combined with unremitting work. Their talents and their work have benefited them to a certain extent, and quite rightly so; the extent to which they have benefited the whole community is greater beyond measure. The names of such men are present in the minds of our readers; they include those of James Watt, Whitworth, William Murdock, Napier, Stephenson, and hosts of others. Men such as these have been styled of the "upper class." They are that, most certainly, and it is such men who very frequently have formed the subject of that kind of senseless jealousy which Mr. J. H. Thomas condemned in very strong terms at the Cutlers' Feast held in Sheffield last week. The way in which he deprecated the recurrence of industrial disputes, the disparagement of any one class or section of the community, the lack of confidence existing between the classes and the danger of continuing the talk of class warfare, is most welcome, and it affords an earnest that he will continue to do all that is in his power to wipe out the evils he alluded to.

In his deprecation of class warfare Mr. Thomas had in mind the sentiment in its generality, and we quite agree that the problem is to be so viewed and to be dealt with as a whole. Class hatred, however, is very one-sided as a rule, and may be said to cover, for the most part, the feeling entertained by the less well-to-do members of the community towards those members who form part of the moneyed class. Some blame may attach to individual units of the latter, traceable probably in the first instance, to lack of education on their part, but occasion for blame, we believe, is gradually decreasing as the years go by. Furthermore, men such as those to whom we have alluded in the foregoing may have given rise to a certain amount of criticism on the ground of inattention to the requirements of the men in their employment; they may even be excused on this score, since in the working out of their life-schemes they have frequently been forgetful of their own selves.

The striving after equality is as old as the hills, and has very generally proceeded upon utterly wrong lines, inasmuch as more often than not it has implied amongst its advocates a levelling down, whereas honourable equality should mean a levelling in an upward direction. Since it is impossible to raise the level by an Act of Parliament, the advocates of the false equality have for many years directed their efforts towards the lowering of the high, a much easier proposition, but one which carried with it an utter contempt for humanity in the full sense of the word. Danton, the French revolutionist, defined equality as meaning "we above, and all high members of the community underneath." A much older partisan of an equally wrong form of equality was Procrustes, a reformer of ancient Greece, who decreed in his own mind that all men should be of his own stature. He tied his prisoners on his bed, stretched the limbs of those who were shorter and cut off the feet of those who were longer than the bed. Both these reformers were to some extent the forerunners of present-day equalising fanatics who demand the distribution of all wealth amongst the whole community, a pretension that rests on such a completely false basis that it is idle to argue it at all.

So long as the world continues there will be men who have the privilege of natural, inborn gifts, such as character, talent, health, energy, capacity for work, and who make use of such gifts in a natural way, and no State decree can remove the advantages which those gifts confer upon such men, nor even is it in the power of the men themselves, so privileged, to agree that they be dispossessed of them by virtue of such a decree. Apart from the personal gifts we refer to, all nature's benefits belong to every man equally and are above paying for; no sum, however high, could purchase one single ray of sunshine.

The men whose inventions have advanced civilisation, and thousands of other men quite as illustrious in their different capacities, form the real aristocracy of the world. Quite on the same level with them we place those whom we may style as belonging to the "fellow-feeling nobility," illiterate men very frequently, representatives of whom have been so ably depicted by Dickens. All these are of the "upper class" and there is room at the top with them for everyone.

It is an undeniable fact of human life that every good quality, especially character, energy, industry and virtue, generates superiority and will continue to do so to the end of time. The acquirement of monetary wealth occasionally follows as a consequence of such natural qualities and of the attainments they give rise to. But, quite apart from such qualities and attainments, what is to prevent an industrious and thrifty ordinary member of the community from outranging, in respect to wealth, one who remains idle or leads a disorderly life? Here we may remark that, compared with the fortunes which have been acquired by honourable means, the number of those acquired dishonestly is very small indeed. In this connection it has also to be remembered that at certain and, no doubt, frequent periods of a man's life, and with given wages, drawbacks and encumbrances, it is difficult to save. It was possible to many during the late war, and the question may well be asked whether all who could be were thrifty during that period.

The men who own the greatest amount of monetary wealth are not the happiest by any means. We add this for the simple reason that the striving after equality resolves itself purely and simply into the striving after happiness. The saying "as happy as a king" has long since lost all reality, if ever it had any. There is on record the story of a king who fell ill of a distemper, and all the doctors of the realm failed to cure him. A wise man of his subjects asserted that the one and only remedy that would avail to save the king's life was for him "to wear the shirt of a really happy man." The courtiers started on their quest for the garment. They inquired of the princes, cabinet ministers, provincial governors, bankers and landed gentry, none of whom were happy owing to being kept in the background, to attacks in the press, the depreciated currency of neighbouring states, or bad harvests. On their way back in great despondency, the courtiers were astonished to hear a man singing. He was a farmer and, asked whether he was happy, he replied he was most certainly so, for he had a good wife, healthy children and his eldest boy was beginning to handle a spade. He was the very man they had been looking for, and they anticipated seeing their king soon restored to health. But they encountered a difficulty they had not bargained for; the man's possessions did not include one single specimen of the garment wanted. The deduction is obvious.

Such are the thoughts which occurred to us when reading the speech delivered by Mr. Thomas at Sheffield. We again welcome his declarations; they give rise to the hope that the solution of the social difficulties and problems which are acting as a brake upon the welfare and happiness of the country will be carried out equitably. The settlement, we are confident, depends upon nothing so much as an accurate knowledge of actual facts by all parties. When the facts are accurately known, the common sense and love of fair play inborn in every British citizen may be trusted to do the rest.

NOTES.

Early Days of Mechanical Road Transport.

Some interesting and little known particulars of the early history of mechanical transport on ordinary highways were related before the Society of Arts on Wednesday evening last. It is, of course, common knowledge that the pneumatic tyre had been anticipated by Mr. R. W. Thomson, who patented the idea in 1845 and fitted pneumatic tyres to a number of vehicles. Rubber technology was at that date relatively little advanced, and manufacturing difficulties were largely responsible for the lack of further development. Whilst the pioneering work of Thomson in this matter has now been fully recognised, the facts brought forward by Colonel Crompton show that he was also the real pioneer of motor transport. His first road steamer was at work in 1867 and attained a speed of 12 miles per hour. Development in this country was, of course, impossible as mechanically propelled vehicles were limited to a speed of four miles an hour, and compelled to be preceded by a man carrying a red flag. In India, however, conditions were different, and Colonel Crompton, learning of Thomson's experiments, succeeded in persuading the Indian authorities to give them a trial. The vehicles, then ordered, had rubber tyres and attained speeds of 25 miles per hour. They were

intended mainly for Post Office service, but in 1873 were employed for military transport in connection with a camp of exercise near Rawal Pindi. It was the experience thus gained which led to Lord Robert's advocacy of mechanical transport in South Africa in 1900. The system continued in use for some years in India until the development of the light metre gauge railways. The road engines first supplied had a weight of 14 tons, which reduced the life of the rubber tyres. Ultimately, however, the weight was got down to 5 tons. Colonel Crompton states that the native drivers became most trustworthy, whereas the European drivers were involved in two terrible accidents arising from drunkenness.

Gas Supply in Liverpool.

The Liverpool Gas Company was formed in 1815 and commenced business in a small way the following year. It now supplies an area of about 57 square miles, stretching a distance of 15½ miles along the river from Garston in the south almost to Formby in the north. The company, owns six manufacturing stations, the two largest being at Linacre and Garston. It was stated by Mr. R. E. Gibson, the engineer of the company, in his presidential address to the Liverpool Engineering Society, on November 5, that by 1822 the quantity of gas sold per annum had amounted to 27 million cubic feet, and the price charged was 45*s.* per 1,000 cub. ft. The output of the company last year was 7,000 million cubic feet, and the present price is 2*s.* 11*d.* per 1,000 cub. ft. or 7·4*d.* per therm. The revenue for the year ending December 31, 1923, was 1,452,313*l.* The number of workmen employed, including the staff, is 2,516, and the mains have an aggregate length of nearly 1,000 miles. In addition to the gas output mentioned, there are produced annually 232,175 tons of smokeless fuel in the form of coke and breeze, 3,096 tons of sulphate of ammonia and 4,237,241 gallons of tar, from which a large number of secondary products are obtained. Other direct products are retort carbon, ferro-prussiate of soda, and spent oxide of iron containing sulphur which is converted into sulphuric acid. The declared heating value of Liverpool gas is 475 B.Th.U. per cubic foot.

The Maclaurin System of Producing Smokeless Fuel.

In connection with the Smoke Abatement Exhibition, which was opened on Tuesday, November 4, in the City Hall, Manchester, a series of meetings was held by the Smoke Abatement League of Great Britain, at which papers on subjects connected with the purification of the atmosphere were read. Amongst these was a contribution from Mr. Robert Maclaurin on the plant which is at present under construction to his design by Messrs. Blair, Campbell and Maclean, Limited, of Glasgow, for installation in the Dalmarnock Gasworks. For some years Mr. Maclaurin has conducted experiments on questions relating to low temperature carbonisation, and from the latest tests it was deduced that a smokeless fuel could be produced by his system to sell at 28*s.* 6*d.* a ton, and that gas could be obtained in the process at something slightly less than one penny per therm. These deductions were based upon obtaining suitable raw fuel at 20*s.* per ton, and taking the yields arrived at in tests and the current value of derivatives such as oil, sulphate of ammonia, &c. The Glasgow Corporation Gas Committee, being convinced that the time had been reached for work on a large scale, ordered the new plant, which consists of five batteries of producers capable of carbonising 36,500 tons of coal per annum. In the Dalmarnock Gasworks the gas produced by this Maclaurin plant will be used to heat the vertical retorts and to raise steam in a boiler capable of evaporating 3,600 lbs. of water per hour. The guaranteed production is specified as not less than what was obtained in tests conducted by the Corporation chemists on the experimental plant at Grangemouth. Estimates have been made that it will cost 51,647*l.* per annum to run the plant, of which 36,500*l.* will be spent on fuel, 2,737*l.* on labour, 5,410*l.* on maintenance, rent, taxes and royalties, the remaining 7,000*l.* representing interest, sinking fund and depreciation. For the gas produced it was estimated that at 0·9*d.* per therm, 9,375*l.* would be obtained. Oils produced would give an income of 11,862*l.* and the sulphate of ammonia obtained would yield 1,973*l.*, which would make possible the sale of the 20,000 tons of smokeless fuel produced per annum at a price of 28*s.* 6*d.* per ton.

Heat Insulators.

A revised edition of the first report of the Engineering Committee of the Food Investigation Board on Heat Insulators, differs from the first edition mainly by the inclusion of the results of further experiments by Dr. Ezer Griffiths on rubber materials. The particular material now tested consists of rubber made cellular and expanded by means of gas under pressure, its structure contrasting with that of a rubber sponge in the respect that its cells are wholly enclosed, while in a spongy rubber they communicate with each other. The most remarkable physical property of this material lies in its density, which varies from as low as 3·7 lb. per cub. ft. upwards, as compared with 14 lb. for rubber sponge and as high as 82 lb. for vulcanised rubber. A hard variety resembling ebonite has a density of 7·6 lb. per cubic foot. Opportunity has not yet arisen for determining the relation between the density of the sample and its thermal conductivity. The specific conductivity of the material varied from 0·00009 to 0·00012 C.G.S. units as against about 0·00011 for cork or equivalent insulators, which weighed 11 lb. to 13 lb. per cubic foot as against 5 lb. to 7 lb., the weight of a cubic foot of the samples examined. Clippings of the material packed into an interspace lightly so as to give a weight of 2·6 lb. per cubic foot gave a conductivity of 0·000118, while packed more densely to 4 lb. per cubic foot the conductivity fell to 0·000106, the closer packing having increased the insulating efficiency by over 10 per cent. The durability of the material under rough usage, its chemical stability, and many other questions in regard to it remain to be further investigated. The conductivity is still considerably higher than that of still air, which is about 0·00005. A report is now in preparation, which includes further tests on insulating materials and their hygroscopic properties. The report in question is obtainable at H.M. Stationery Office at the price of 2*s.* net.

Testing Water-Gas Plants.

The object of the "Critical Study of the Published Results of Tests of Water-Gas Plant," which Dr. M. W. Travers, F.R.S., presented to the Institution of Chemical Engineers on the 5th inst., was to obtain a kind of trading account to show the relationship between the three distinct processes of the water-gas process—*viz.*, the blow, the run and the clinkering process, and not merely the chemical and thermal balance sheets. For his analysis, which Dr. Travers based on reports published by the Fuel Research Board and by a Committee of the Institution of Gas Engineers, he regarded the three sub-processes mentioned as taking place independently, though he was aware that this is not strictly admissible. He concluded that it was possible to compile balance sheets showing not only how the total energy of the fuel was utilised, but also the relationship between the run and blow if these two did not balance, the experimental results were at fault. Errors would arise because temperature measurements did not indicate the actual gas temperatures, very difficult to determine even by thermo-couples. Another source of error was the uncertainty of the amount of air admitted and of the moisture in it. Since the blow only lasts a minute that determination is very difficult, but it had been attempted in the tests referred to at Greenwich and Birmingham; some of the Birmingham tests were, however, made with the exclusive object of determining the efficiency of the water-gas generator as actually worked, as Mr. J. S. Townend remarked. Moist air, and more still the condensation of steam in the plant, Dr. Travers pointed out, reduce the efficiency; preheating of the steam for the run was advisable. British practice favoured a water gas of the following percentages: CO_2 5·5, CO 39, H_2 49, CH_4 0·5, N_2 6; Dr. Travers did not criticise nor justify this composition, but he considered ratios of CO_2/CO ranging from 1/9 to 9/1, and he showed that an increase in this ratio augmented the water-gas output per ton of coke. His main point was that no allowance was usually made for loss of carbon otherwise than as ashes, and that there were considerable carbon losses during the clinkering, to determine which further experiments should be conducted with fuel beds of constant depth changing one of the other factors at a time. In his calculations he had used the ounce-molecule, which is convenient for the conversion of the metric data of chemists into the British measures of the engineer, and also the C.H.U., the heat unit per degree Centigrade. This latter was objected to, and a general desire was expressed that the Institution of Chemical Engineers should take up the question of units.

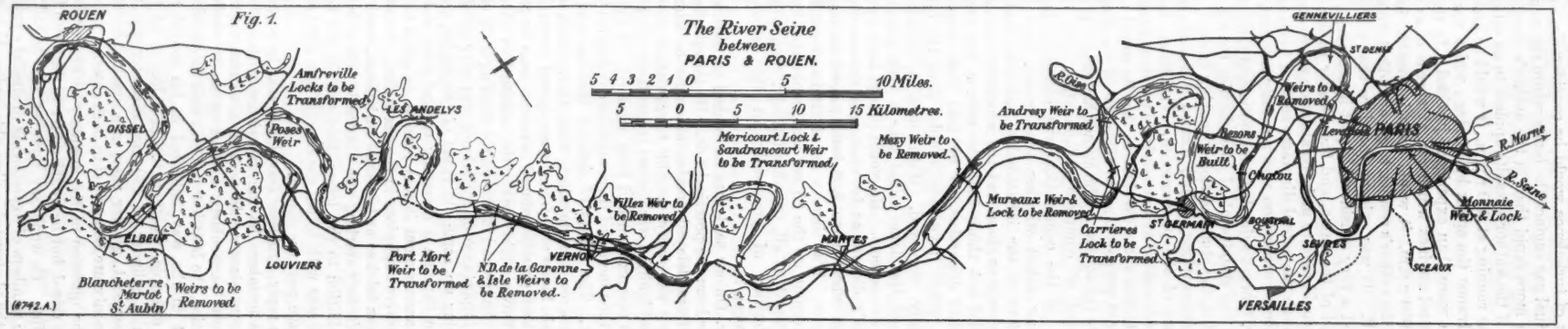
The Ramsay Laboratory of Chemical Engineering.

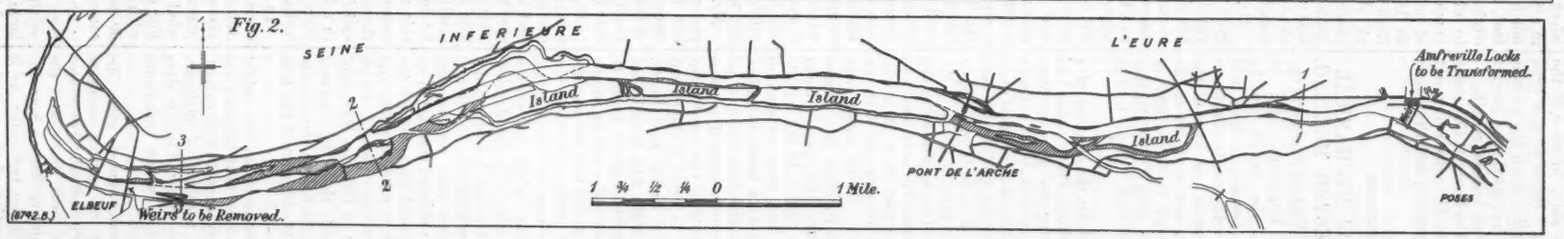
On Wednesday last, the 12th instant, the new Ramsay Laboratory of Chemical Engineering at University College, London, was opened by H.R.H. Prince Arthur of Connaught, K.G., K.T., who is President of the University College Equipment and Endowment Fund Committee. The chair on the occasion was taken by Sir Robert Robertson, K.B.E., F.R.S., and at the conclusion of the ceremony the laboratory was opened for inspection. The aims and objects of the new laboratory were explained in an inaugural lecture delivered some months ago by the Ramsay Professor of Chemical Engineering, Mr. E. C. Williams, M.Sc., F.I.C., and were referred to in our issue of January 25 last, on page 116. We may mention, however, that, broadly, its function is to provide an efficient training for chemical engineers in physical chemistry. An existing building having entrances in Gower-place and Golden-street was acquired, and has been reconstructed for the purposes of the laboratory, giving accommodation for about 24 students. On the upper floor of the building is a special laboratory for advanced research workers, a drawing office and a general laboratory for the ordinary students, who are of the post-graduate standard. This general laboratory is employed for the determination of data required for the design of plant on an industrial scale; in connection, for example, with the theory of selective absorption, the heats of reactions, latent heats, &c. The administration offices, professor's rooms and private laboratories are located on the ground floor, while the basement is occupied with chemical apparatus on a semi-commercial scale. This class of equipment includes a gas-fired, or steam-heated, still with a dephlegmating column and condensers specially designed by Professor Williams to facilitate quantitative measurements. Other items of equipment which may be mentioned are apparatus for measuring the heat transmission through the walls of tubes from condensing vapours, apparatus for determining the fundamental conditions of design for gas-absorption towers, filtration apparatus and a variety of apparatus for measuring the flow of liquids and gases, the friction of liquids in pipes, &c. The principle of working, Professor Williams informed us, will be for a student to complete an investigation on a laboratory scale, and afterwards to check his results on a semi-commercial scale in the basement laboratory, where he will also obtain such experience in fitting and the erection of plant as will be required for his own experimental work. Professor Williams has the assistance of Dr. Burrows Moore in the work of the department, which has already commenced, several students being now in attendance.

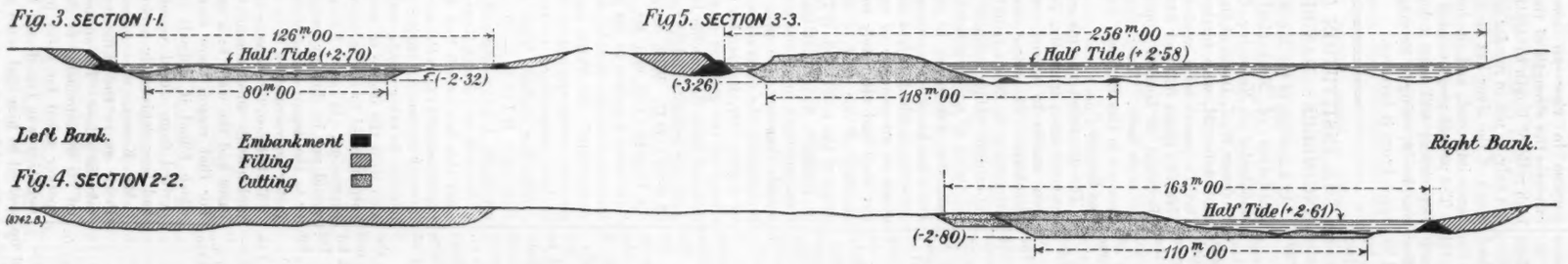
THE REGULATION OF THE RIVER SEINE.

The rise in the levels of the Seine and Marne and consequent flooding in the last few days recall the extensive rise in the Seine level which took place in the year 1910, which has led to the propounding by various experts of schemes for improving the flow of the river with a view to prevent the recurrence of inundations. The course of the Seine between Paris and Rouen is shown in Fig. 1, opposite, and as will be seen, its principal tributary is the Marne, which flows into it just outside, and to the East of Paris. The Marne contributes to a very large

THE REGULATION OF THE RIVER SEINE.







extent to the variations occurring from time to time in the Seine level. Most of the schemes to which we allude, including one for the provision of large capacity storage reservoirs up-stream, and one for a Marne derivation canal, have been set aside, although this latter would, in all probability have been attended with excellent results from the standpoint of flood risks. Since 1910, the Ponts et Chaussées Department has undertaken several remedial measures at various points between Paris and Rouen, and these have proved so far successful that the rise in the river a few months ago was not attended with any very serious effects; it should be remarked, however, that the swelling of the Seine this year did not quite reach the very high level of 1910.

Every means taken to improve the river flow, in order to prevent the evil consequences for Paris and other localities attendant upon an untoward rise in the river level, have to take into account the fact that the Seine between Paris and Rouen constitutes a most important fairway for goods traffic. The tonnage carried has greatly developed during past years, and reached in 1913 a total of 4,054,536 tons, of which 3,491,739 tons were up-stream traffic to Paris. In 1923, the corresponding figures were 6,167,974 tons and 5,649,375 tons. These figures give an idea of the very important part which the Seine plays in the commercial activity of the French Metropolis, and suggest, quite apart from the direct losses due to inundations, the losses which follow an interruption in the river navigation service.

A few particulars concerning the present conditions under which the Seine goods traffic is now carried on between Rouen and Paris will be found of interest. The minimum depth of water in the fairway is 3·20 m. (10 ft. 6 in.), which allows the circulation of boats drawing up to 3 m. (9 ft. 10 in.). This has been ensured by the construction of nine weirs and nine series of locks. The weirs are of various types and are all movable, and allow of free navigation over the navigable passes at high water mark. The weirs are in general of the needle or stop-plank type.

In connection with each series of locks there is at least one small lock, the dimensions of which is never less than 53·75 m. (176 ft.) in length and 8 m. (26 ft. 3 in.) in width, and a larger one having a width of 11·80 m. (38 ft. 8 in.) at the crowns, the lock chamber measuring 141 m. (462 ft.) in length and 17 m. (55 ft. 9 in.) in width, allowing the simultaneous locking of a tugboat with its set of barges. The greater part of the traffic is carried in towed barges. The largest of these take as much as 1,500 tons; most of the Seine barges are, however, of from 700 to 800 tons, and an important portion of the traffic is by canal barges of about 300 tons capacity which can circulate both on the Seine and throughout the French canal system. The tugboats are propelled by engines of 500-h.p. and over. Of late years, goods traffic on the river by steamers and motor-boats has greatly developed, and is on the increase. Among these boats some ply a regular service between France and England. Their capacity has, however, remained somewhat low; it does not exceed a few hundred tons, owing to the low permissible draught, a maximum of 3 m. (9 ft. 10 ins.) during the greater part of the year, owing also to the available height under bridges, this being 5·5 m. (18 ft.) at low-water mark and 4 m. (13 ft.) and less at high-water mark. The boats exceeding in length that of the smaller locks, 176 ft., would, moreover, under the present traffic conditions, lose much time in passing from one level to

another. When the fairway is improved a better steamer and motorboat traffic with Paris will be possible.

The scheme now being carried out by the Ponts et Chaussées Department has for one of its purposes to establish in the fairway a depth of 5 m. (16 ft. 5 in.). This will hardly meet the conditions required for making Paris a "seaport," but when reached it will aid in developing traffic, and will lead to a decrease in the cost of transport of much of the goods and materials consumed in the French capital and neighbouring districts. Whilst improving navigation, the work will also greatly facilitate the flow of the river—a pressing necessity, as was proved by the inundations of 1910 and, to a lesser extent, by the more recent flood. Coupled with these two main objects it is intended to utilise the differences of level for generating electric current, a quite feasible undertaking, notwithstanding the irregularity in the river discharge.

The regulating of the Seine between Paris and Rouen from the three standpoints, navigation, lowering the flood level and utilisation of the falls, involves the following works, several of which are marked in the map, Fig. 1:—The reduction from nine to six of the retaining weirs and locks; the provision of a minimum depth of 16 ft. 5 in. at low water; the regulating and lowering of the flow in the fairway by improving the course and width of the latter, the width to be, as a minimum, 80 m. (262 ft.); reconstruction of bridges where necessary, with a view to increase to 6 m. (19 ft. 8 in.) above highest water-mark the available height under them. The two retaining systems at Meulan and Méricourt are to be combined in one only, the same to be the case with regard to those at Port-Villez and N.D. de la Garenne. On the down-stream side of Poses, near Elbeuf, an important modification is the removal of the Martot weir, the effect of which will be to allow the tides to exert their action as far up the river as the Poses weir. The work at this part is to include a deepening of the Martot channel, and the construction of a new lock by the side of the present locks at Poses, which are to be transformed. The regulation thus carried out will allow of generating in an average year as much as 70,000,000 kw.-hours, 45,000,000 of which can be sold to advantage. A company having asked to be granted the concession of the Poses waterfall, on payment of a subvention for carrying out the work on this section of the river, the necessary means have been taken for dealing rapidly with this part of the Ponts et Chaussées scheme. We illustrate in Fig. 2 the reach between Poses and Elbeuf, and in Figs. 3 to 5 cross-sections at different parts of this reach.

At the same time, steps are being taken for improving the river flow in the neighbourhood of Bougival, closer to Paris. Operations at intermediate weirs and locks are then to proceed, the more urgent regulation work being done first, with a view, in the first instance, to forming a depth of 3·5 m. (11 ft. 6 in.). Later on, the deepening of the fairway to 5 m. (16 ft. 5 in.) will be effected by stages, simultaneously with the widening of the fairway at each separate stage.

Whilst dealing with the improvement of the Seine, the Ponts et Chaussées Department has under consideration the design of a cargo-boat for direct sea and river service as far as Paris. Its principal dimensions and characteristic features, for a steamer or Diesel boat, are the following :—

Length between perpendiculars	72·75 m. = 238 ft. 8 in.
Extreme breadth	10·50 m. = 34 ft. 5 in.
Depth of hold to top of keel amidships	4·20 m. = 13 ft. 9 in.
Draught in fresh water ...	3·30 m. = 10 ft. 10 in.
Capacity of wing-ballast tanks	542 tons.
Capacity of holds — steam cargo boat	1,318 tons.
Capacity of holds—Diesel-engined cargo-boat ...	1,409 tons.
Two triple-expansion condensing engines	500 h.p.
One steam boiler, heating surface	150 sq. m. = 1,614 sq. ft.
Two Diesel engines	500 h.p.
Speed	9½ knots to 9¾ knots.

The draught of the boat on arriving loaded by sea at Rouen, could be increased by filling the water-ballast tanks for steaming up the river in periods of high water. For steaming down the Seine light, in the absence of counter-freight, the tanks and holds could also be filled with water to give the boat the required draught; the holds are designed with watertight bulkheads with this purpose in view—an arrangement which also increases the strength of the ship, in view of the high ratio of length to depth. Boats of this type can only be put in regular service when the present depth of the river has been increased, the shorter bends improved, and the lower bridges rebuilt.

The present programme of the Ponts et Chaussées Department will take a long time to carry out completely, owing to its magnitude and the heavy expenditure it involves.

THE INSTITUTION OF MECHANICAL ENGINEERS: MANCHESTER MEETING.

At a meeting of the North Western Section of the Institution of Mechanical Engineers, held at Manchester on November 6, the papers read by Professor W. T. David at the London meeting, held on October 24, were further discussed. Professor David's papers were reprinted in our issue of the 31st ult., pages 623 and 629, and a report of the discussion at London appeared on page 605 of the same issue. They dealt with "The Missing Pressure in Gas Engines" and with "Heat Loss in Gas Engines."

The discussion was opened by the reading of a communication from Mr. Telford Petrie, who had been unable to attend owing to absence from Manchester. The writer observed that the author's estimates of the delayed combustion were based upon the calorific values assigned to the fuel, which were calculated to one-hundredth of a centigrade heat-unit, that was to say to one part in 2,000. Mr. Petrie had himself been engaged in the Steam Nozzles research, in which it had originally been hoped to attain to an accuracy of one part in a thousand, but they had ultimately to be satisfied with an accuracy of one part in 500. With small heat drops of the order of 3 B.Th.U. even this degree of precision was unattainable, the results being then uncertain to ± one per cent. In the reports issued, therefore, the plan had been adopted of representing the observations by a band instead of by a line. Mr. Petrie also asked how the internal energy of the gas was measured, since if it were deduced from the specific heats of the constituent gases the estimates might be in error to the extent of 0·95 C.H.U. With respect to the heat losses. Sir Dugald Clerk and Mr. Burls had stated that "the total heat loss to the jacket water is found to increase with the density, but not quite in simple proportion." Mr. Petrie suggested that the explanation lay in the application of Osborne Reynolds law of heat transmission to the case of the internal combustion engine. That law might be written $H = (A + B\,d\,v)\,(t_1 - t_2)$ where d is the density, v velocity, t_1 temperature of the gas, t_2 temperature of the wall, and A and B are constants. It followed from this law (which had been fully corroborated experimentally) that the rate of heat transfer in an internal combustion engine would increase with the density, in other words, with the compression, and also with the degree of turbulence present, which corresponded to the velocity in Osborne Reynolds' expression. It also followed that the increase would not be directly proportional to the density or to the degree of turbulence, because of the first factor represented by $A\,(t_1 - t_2)$.

Turbulence, by scouring the inert gas film, might undoubtedly affect conduction of heat between the gases and the walls to a very considerable extent. For that reason there was a school of engineers which found it difficult to apply directly data derived from closed vessels in which turbulence had been deliberately avoided.

Mr. Kersey, who followed, agreed with Mr. Petrie as to the difficulty of getting accurate calorific values. The author's deductions depended on his measurements of the heat losses, and the speaker asked for fuller information as how the radiation was transferred to the bolometer, as it seemed to him that some portion of the radiation reflected from the polished surface would not reach the instrument. As for conduction losses, the author stated that these were nearly independent of the size of the vessel, whilst the radiation losses did depend on this, as well as on the temperature of the gaseous mixture. The matter was evidently very complex. He agreed with the author that dissociation must be small, but he thought that the effect of turbulence would be considerable, so that in actual gas engines the temperature rise would be much more rapid than in the author's vessels. In fact, if the author's results applied to an actual gas engine running at 300 r.p.m., it would be necessary to advance the spark by 60 deg., which was very much more than experience justified. In the case of petrol engines which ran at speeds of as much as 3,000 r.p.m., it would seem impossible, judging from the author's results, to get an indicator diagram at all. It was evident therefore that turbulence played a very considerable part in securing a rapid spread of the flame, and the speaker thought that this would tend to make combustion more complete, although the actual diagrams seemed to show that complete combustion was not fully attained.

Dr. Coward said that he approached the problem from the standpoint of the chemist having spent years in the study of slowly-moving flames. From his observations he had formed a definite mental picture of the phenomenon. The flame, he considered, started at some definite point, and travelled as a hollow spherical shell, so that its actual volume was not proportional to the cube of the diameter, but to the square. The author had said that at the moment of complete inflammation only 75 per cent. of the combustion was complete, and the speaker asked whether that meant that three-quarters of the inflammable molecules had been completely oxidised and the remainder untouched? He did not think that the author had used the simplest apparatus, as he held that a spherical shell would have been simpler than the cylinder actually employed. With such a cylinder, he thought the flame might take a little time to get into the corners. He would like to have Professor David's dictum as to what was the condition of things when flame had been passed through the mixture. Was there a lot of luminous gas behind it sweeping up the 25 per cent. molecules that had not burnt at all, or, alternatively, completing the combustion of practically all the carbon and hydrogen?

Mr. Onions said that he wished to consider the paper from the practical side. He thought that the loss from delayed combustion must be admitted, since it was always possible to regulate a gas engine so that ignition was started immediately after maximum compression had been attained. If the pressure then increased there must be combustion taking place. The effects of delayed ignition were soon felt, since the spindles were then burnt away. Certain losses also arose from exposed areas. These had been greatly reduced in recent years by putting the valves right inside the combustion chamber. This change had improved the running of the engine. The importance of turbulence was very great. In starting up, some old types of gas engine, gas was let in through a diverging conical hole, and with this arrangement it was possible to get a series of successive explosions in the one strike. By altering the gas inlet so as to secure turbulence, much more satisfactory starting was obtained. He added that in addition to the losses discussed by the author, there was with actual gas engines also some loss by leakage past the piston.

In reply, Professor David said that he hoped that some members having experience with engines of different sizes would send in a written discussion. He was particularly anxious to know whether in practice, the heat loss per unit area increased somewhat in the way indicated in his second paper. For example, whether, the heat loss in an engine with a cylinder of 150 cm. diameter was about 50 per cent. greater than in a small cylinder, the same mixture being used in both cases.

The question of the accuracy of his results had been raised, but he would prefer to deal with this in writing. He would say, however, that he had made large numbers of experiments in similar conditions, and the photographic films obtained could be superimposed. He was certain that his most important results were true to at least 1 per cent. Dissociation at gas-engine pressures was not as much as 3 per

cent. at 2,000 deg. C. With respect to the conduction losses, Mr. Kersey had wished to know why these varied with the fourth power of the absolute temperature. The speaker thought this was due to the little volume of gas interposed between the hot burning gas and the metal wall. The surface layer was cooled and became an effective insulating jacket, so that heat was transferred across, with more difficulty the lower its temperature.

LABOUR NOTES.

Mr. Stanley Machin expressed a hope the other day at a meeting of the Birmingham Chamber of Commerce that the workers realised the effect on the cost of living of the increases of wages that were being paid in sheltered industries. These extravagant rates constituted, he said, one of the main causes of the high cost of living. There is, unhappily, little ground for the hope. On the contrary, the rates paid in sheltered industries are regarded as standards by Labour's extremists, who persistently cite them to their fellows in unsheltered trades as evidence that their employers are grossly underpaying them. The truth is, as everybody in competitive industry knows, and as Sir Allan Smith showed to the engineering trade unions, that the wages ruling in unsheltered industries to-day are economic, and ought, in the interest of British industry as a whole—also in the interest of British labour as a whole—to be the standard to which those in sheltered industries conformed, instead of the other way about. Mr. Machin indicated the effect on cost of living of the extravagant rates paid in sheltered trades. Their effect on production costs is, however, no less serious. Local rates are, for example, a very heavy burden on competitive industry, and the high level to which they have been raised is unquestionably due to the high wages paid by urban, suburban and rural authorities. Comparisons of the wages paid to tramwaymen and dustmen—to name no others—with those paid to, say, skilled mechanics never fail to leave the latter class discontented. But if skilled mechanics realised that their wages are low, and their employment intermittent, because the tramwaymen's and the dustmen's wages are high and their employment continuous, they would be on the way to a solution of British industry's present difficulties.

According to a Russian official statement, the collective agreements between the trade unions and the administrative boards of enterprises are now up for revision, and the All-Russian Council of Trade Unions and the Union Supreme Economic Council have issued a joint circular to all trade-union organisations, trusts, and the Economic Councils of the Republics of the Union, suggesting the lines upon which the reviews of them should proceed "in order to create conditions for raising the productivity of labour to the highest point possible in the present economic and political conditions of the U.S.S.R."

Amongst the principal measures suggested for increasing the personal intensity of labour is the more extensive introduction of piece-work. Wherever possible, it is laid down, the workers should be paid on a piece-work basis, and all the existing limitations in this respect are to be abolished. The results of the introduction of unlimited piece-work are to be watched very carefully in order to establish its advantages and disadvantages, particularly as regards the quality of the manufactures as well as the manufacturing costs. With the extensive introduction of piece-work, proper standards of work, as regards both quantity and quality, are to be fixed. The methods and organisation of the work must, it is stated, be gone into more carefully, the intensity of labour raised, and exact rates of pay for the various classes of work decided. In addition, subsidiary and casual labour are to be reduced to a minimum, and day workers are to be employed as job workers or by contract and to be paid accordingly. In certain cases, by way of experiment, and after fixing strict maximum quantities, special rewards are to be granted for economy in the use of fuel and raw materials below the fixed maximum.

At the recent meeting in Brussels of the Miners' International Committee, Mr. Herbert Smith, president of the Miners' Federation of Great Britain, said that while there were still a great many miners idle in Great Britain through the closing of pits, the membership of the Miners' Federation was back again to the pre-war numbers and was still increasing. The divisions which existed in their ranks in 1921 had almost disappeared. When, in June of next year, the present wage agreement expired, the Miners' Federation would be in a better position than ever before to enter into negotiations for an improvement of the miners' status.

The German miners are, it seems, to be supported by the international organisation politically, industrially and financially if they strike at the end of this month in order to force the employers to revert to the seven-hour day for underground workers. In Germany, the seven-hour day was secured by agreement with the mineowners—not, as in this country, by legislation—and when reparations came to be paid, the mineowners asked the men to work an hour overtime per day without remuneration. Speaking as chairman of the International Committee, Mr. Smith said that with all the desire which the miners had to work on peacefully, they could not continue to accept their present low economic position either in Great Britain or in any other country. There must be, he declared, considerable improvement in wages if there was to be continued peace in the industry.

At its Prague congress, the Committee decided, in principle, to set up a permanent international secretariat. The Brussels meeting passed a resolution embodying a decision that the appointment of the permanent international secretary should be made in January at the meeting at Hanover which is to discuss the Dawes plan. A special levy of five gold pfennigs per member is to be made before the end of this year in order to provide funds for the upkeep of the secretariat and the publication of an international bulletin. The membership of the organisations affiliated to the International Federation is 1,972,000.

The Committee also decided, in principle, to accept the invitation from Soviet Russia to send a commission of inquiry to report on the position of the mining industry in that country.

Continental trade unionists are much less tolerant of Communists than their fellows in Great Britain are as a rule. It is stated, for example, that the Belgian, French and German miners regard the Communists in their midst as a danger to their organisations and act accordingly. In Germany when a miner avows himself to be a Communist he is expelled from the union. Metalworkers belonging to the smaller nationalities have complained bitterly at International Conferences about the activities of the same disruptive element; this was, in fact, the principal ground of their objection to the admission to their International of the Russian metal-workers. In this country, so far from excluding Communists from membership of their organisations, the members of several unions have elected them to high executive office.

It looks, however, as if, before long, the members of British trade unions will have to exert themselves in order to maintain their constitutions against the attacks, once veiled, but now open, of the Communists. The National Minority Movement of Moscow's Red International Labour Union grows bolder every week in its propaganda and at its selected moment—when, that is, an important union is engaged in critical negotiations with employers—it may easily do irreparable damage to the structure of the organisation which labour has evolved in the course of many years. Representative British trade unionists are not, of course, blind to the danger. They foresee exactly what will happen if the R.I.L.U. gets its way, and in more than one influential quarter there is talk of taking steps to prevent it. Exactly what these steps are is not clear at the moment, but it is significant that official circles are concerned about the new move to enrol workers in the National Minority Movement at a subscription of 1*s.* per head. Unions with declining memberships naturally view with concern this further interference with their activities.

The Building Industry Committee appointed by the Ministry of Health has issued a circular letter to local organisations of employers and operatives throughout Great Britain drawing attention to the proposals for securing the necessary increases in the skilled ranks of the building industry contained in the report upon the building industry by representatives of employers and operatives issued in April last. The report asks for the appointment of local joint apprenticeship committees throughout Great Britain in order to help in carrying out these proposals and urges the desirability of complete co-operation in all steps proposed to secure the desired end. Pending the formation of these local committees, the Building Industry Committee is considering the machinery which should be set up for carrying out the other recommendations made in the report. The Building Industry Committee, whose primary function is to assist in the augmentation of the supply of skilled labour, is at present composed of representatives of employers and operatives, but representatives of the manufacturers and suppliers of building materials will be added when nominated by them.

Speaking at the annual meeting in London of the Industrial Welfare Society, of which he is president, the Duke of York said that the work of the society was neither spectacular nor capable of producing immediately visible results, but those who had studied welfare work in operation knew full well that it was making a real and effective contribution to stability, peace and efficiency in the industrial life of the nation. It was not to be expected that happiness, understanding and confidence between man and man could be attained by the mere production of any scheme, however lofty its ideals and noble its purpose. The society had urged the great moral principles underlying the relations between master and man, and shop by shop, yard by yard, and mine by mine, it had implanted the seed which gradually but surely was ripening to a real desire for mutual understanding. To suggest methods and supply the technique necessary for translating goodwill into action was the work of the society, and as time went on its need and usefulness would be more and more recognised.

Lord Invernairn, chairman of the Society, in moving the adoption of the annual report, said that though the organisation had never before been in so sound a financial position, that fact was due to economies which all regretted and to the splendid generosity of warm friends. To many who might help, their work was not sufficiently well known. They could make no attractive appeal to sentiment; they could not point to sufferers relieved and cases helped; but nothing in the present stage of the country's development was more important or fraught with greater possibilities for happiness and stability. They were certain that the work done so consistently and doggedly during the last six years had already made, and was making, its mark for good upon the nation as a whole. He hoped that those who were in a position to help would give greater heed to the society's very real claim and not allow it to languish for want of funds.

The Ministry of Labour reports that the number of unemployed persons on the registers of Employment Exchanges in Great Britain on November 3, 1924, was 1,228,000—938,200 men, 35,200 boys, 223,500 women, and 31,100 girls. On October 27, 1924, the number of unemployed persons was 1,203,229—910,495 men, 35,665 boys, 225,107 women and 31,962 girls—and on December 31, 1923, 1,285,623—946,521 men, 36,659 boys, 267,373 women and 35,070 girls.

At Hull City Council on November 10, it was proposed that no tender for any municipal contract should in future be invited or accepted from foreign firms whose hours of labour and rates of pay were less favourable than in this country. In support of the resolution, it was urged that it was unfair to insist on fair wage clauses at home and not to apply the same principle in the case of foreigners. Opponents of the proposal contended that the effect of its adoption might tend to strengthen rings in this country, and eventually the resolution was rejected.

A further conference on the wages question is to take place in Glasgow on Thursday next between representatives of the National Light Castings Ironfounders' Federation and the Negotiating Committee of the twelve trade unions supporting the application for an advance. By a majority of 8 to 1 the men in a ballot vote decided to give the committee power to call a strike if the Employers' Federation did not make a satisfactory offer. The application is for the restitution of "cuts" in bonuses, amounting to 15*s.* per week for men, with corresponding amounts to youths and lads. The men contend that trade has recovered sufficiently to enable the restitution to be made, without endangering trade prospects.

Norton and Gregory Engineering Scholarships.—Messrs. Norton and Gregory, Limited, offer two engineering scholarships to be competed for annually, one value 100*l.* per annum and one value 50*l.* per annum, tenable for three years at any University in the United Kingdom or British Dominions, which may be approved by the Committee. This Committee consists of Sir Joseph Petavel, Professor Inglis, Professor Coker, Mr. J. Talbot, the Master of Haileybury College, Mr. G. H. Burkhardt, Principal of Swindon Technical Institution, and Dr. R. S. Clay, Principal of the Northern Polytechnic Institute. Candidates for the scholarships must have reached the age of 17 but not the age of 19, on the 1st day of March in the year of examination, be domiciled in the United Kingdom and undertake to pursue a three years' course in engineering with a view to following it as a profession. The successful candidates will have to satisfy the Committee that their financial resources are insufficient to give them the course of study suggested, but some form of honorary scholarship may be awarded to successful candidates who cannot furnish this evidence. Papers which will cover two days' examination will be set in English Mathematics, Mechanics and General Physics. The examinations for the 1925 scholarships will be held on March 5 and 6, and application forms should reach the secretary of the committee no later than the last day of January, 1925. The awards will be published on May 15, 1925. Application forms may be obtained from the Secretary, Scholarship Committee, Messrs. Norton and Gregory, 1 and 2, Castle-lane, Westminster, London, S.W. 1.

THE LATE MR. H. C. BARNARD.

The death of Mr. Henry Cuthbert Barnard, J.P., M.Inst.C.E., of The Grey House, Yatton, Somerset, on the 7th inst., removes an engineer associated with the Far East. Mr. Barnard was born in 1865. An old Crystal Palace Engineering School student, on completing the course in 1884 he was articled to Mr. G. J. Margary, engineer to the South Devon and Cornwall Railway Company. His first work in the East was performed, under Mr. J. V. Owen, when he spent a short time erecting tea factories and machinery in Ceylon in 1887. He was then appointed by Sir Frederick Weld, Governor of Straits Settlements, to be assistant district engineer at Taiping, Perak, under Mr. F. Caulfeild, State engineer.

In 1889, Mr. Barnard was transferred to the Railway Department under Mr. C. R. Hanson, resident engineer. The following year he was appointed acting resident engineer, which post he held until 1903. During this period Mr. Barnard had charge of the completion of 67 miles of railway under construction, which included the boring of three tunnels and the erection of several bridges. He was also responsible for the traffic and locomotive departments of the Perak Railway.

After concluding this work, Mr. Barnard continued to act as divisional engineer to the entire railway group which, at this time, resulted from the amalgamation of the other lines in the Federated Malay States with that at Perak. He was confirmed as such in 1903, and devoted his energies to the improvement and development of transport facilities in Malaya until 1916, when he retired on pension, taking up residence in England. Despite his long absence abroad, Mr. Barnard took a keen interest in local affairs in Somerset on his return to this country, and his death will be deeply regretted by friends in both hemispheres.

PHYSICAL SOCIETY OF LONDON.

At the meeting of this society held on October 24, at the Imperial College of Science, with Mr. F. E. Smith, F.R.S., in the chair, a paper "*On the Temperature Gradient in Gases at Various Pressures*," by Messrs. W. Mandell and J. West, was read by Mr. West. The paper stated that a careful re-examination of the problem of the temperature gradients through gases at various pressures had been attempted. Sets of curves indicating these gradients at various pressures and other interesting relations were obtained. Amongst other features, they showed quite definitely the existence in contact with the vessel walls—at low pressures—of very large "temperature jumps." An attempt to explain the general character of the results was based on the assumption of the presence at the walls of a gas film possessing certain properties due to the attracting forces existing amongst wall molecules and gas molecules. Instead of using one thermocouple only to determine the temperature at any point in the enclosure, several thermocouples of differing thicknesses—and, therefore, differing curvature—were employed under identical conditions. Systematic differences amongst corresponding readings of the thermocouples were noticed. These might be attributed to the presence round the various thermocouples of gas films whose thickness and character varied with the thickness of the couple.

Opening the discussion, Mr. B. S. Gossling said that the temperature in a space containing gas at low pressure was one of those delicate and uncomfortable subjects which should be mentioned only in carefully chosen society; he felt, however, that with the present authors it was in perfectly safe hands. He thought that the authors had dismissed the influence of radiation rather briefly. At the end of their theoretical discussion the authors spoke of the Langmuir film. The word "film" which had come into use in this connection seemed a misnomer, as it denoted a region 4 mm. thick—viz., that in which convection ceased and conduction only was effective, a discontinuity at the edge of this region being indicated by optical experiments. The authors' discussion of a really thin film was very interesting, but such a film was quite different from the Langmuir layer. The continuation of the authors' work might throw some new light on the nature of the adsorption of gases. An interesting case would arise where the hot plate was incandescent, but the difficulties involved in an experimental investigation of it would be considerable.

Dr. Ezer Griffiths thought it was a pity that the discussion of the methods of deducing true temperatures from the indications of the thermocouples should have been deferred, for it was difficult to assess the value of the theoretical edifice which had been built up unless one was satisfied as to the experimental foundation. He had not had the opportunity of studying the paper in detail, but glancing through it found no reference to two papers by Mr. G. H. Henderson in the *Physical Review* for 1920, entitled "A New Method of Determining the Temperature Variation of the Thermal Conductivity of Gases," and "The Determination of the Radiation Error in the Measurement of Gas Temperatures." Henderson's method was similar to that of the authors, but his thermocouples were of much finer diameter, 1 mil as compared with the 5 mils of the present authors. One of Henderson's remarks in his conclusions might be quoted: "One point is clearly brought out in the present work, viz., the unreliability of temperatures as indicated by a temperature-measuring device placed in a gas in the presence of surfaces at temperatures differing considerably from that of the body of the gas." He suggested that the authors should make a careful intercomparison of their work with that of Henderson, for he seemed to have devoted much time to the problem of the measurement of temperature at a point in the gas. Personally the speaker said he would favour a method of determining the temperature gradient by some interference method utilising the change of refractive index of the gas with temperature. As regards Mr. Gossling's remarks concerning the Langmuir film theory, this had received considerable modification, and he would refer him to a paper by Mr. Chester W. Rice, in Journ. Amer. Inst. of Elec. Eng., 1923.

Mr. Gossling agreed that the Langmuir theory had been modified, but pointed out that the boundary of the Langmuir region, now assumed to divide the turbulent from the streamline motion in the gas, occurred at a definite distance from the solid surface. Interference methods of measuring temperature lead to difficulties at low pressures, where "temperature" ceased to have a useful physical meaning.

Mr. C. R. Darling referred to the discrepancy between the readings of the two thermocouples, and suggested the use of flat strips similar to those employed by Dr. Moll. The Langmuir layer need not be an actual layer; all that it implied was that in the region in question thermal phenomena were the same as they would be if such a layer existed. He had determined the temperature distribution in badly conducting solids, such as magnesia and asbestos.

A paper on "*Vectorial Dimensions*" was read by Mr. J. F. S. Ross, A.M.Inst.C.E. The paper drew attention to the deficiency of the present dimensional notation [M] [L] [T], and in particular to the anomalies (*a*) that it made the dimensions of work and torque the same, and (*b*) that it allowed the dimensions of angular velocity and acceleration to appear as functions of time alone. It was shown that these defects were due to the neglect of the vectorial character of length, and it was accordingly proposed that the present notation be modified by using the symbols $[L_x]$, $[L_y]$, and $[L_z]$, where different directions were involved. The application of the proposals was shown, and it was demonstrated that they not only remedied the defects noted, but also exhibited the connection between the vectorial characteristics of a quantity and its dimensions. Incidentally it was pointed out that the distinction between vector and scalar quantities was not always easy to apply, and new classifications were suggested. A proposal by Bartorelli to treat angle as a fourth independent fundamental quantity was examined. It was shown that such a change was open to serious criticism, and that it would not achieve the objects aimed at by the proposals in the present paper.

Dr. J. S. G. Thomas, opening the discussion, said that the subject of the present paper had been raised by Sir Oliver Lodge in *Nature* in July, 1888. It was discussed by Rücker in the Proceedings of the Physical Society of November 24, 1888; there would be found some remarks by Professor S. P. Thompson covering points dealt with in the present paper. The whole subject had been gone into very fully by Mr. W Williams in a paper entitled "The Relation of the Dimensions of Physical Quantities to Direction in Space," Proc. Phys. Soc., vol. xi, 1890–92.

Mr. Rollo Appleyard said that the whole subject became clear and the notation ceased to be ambiguous if imaginary quantities were introduced as in vector analysis.

Dr. G. Temple drew attention to an aspect of the subject not treated, he thought, in the memoirs to which reference was made by the first speaker. This was the relativistic aspect, or the view we gained of the subject when it was illuminated by the pure rays of the special theory of relativity. The leading idea of this theory, in the famous dictum of Minkowski, was that "henceforth space and time are but as shadows cast by the fundamental physical reality, space-time"—that entity which has formed the subject of the philosophical researches of Dr. Samuel Alexander. According to that theory a lapse of time and a stretch of space were simply intervals in space-time measured in mutually perpendicular directions. This confusion of time and space issued at once in the paradox of the equivalence of energy and mass, but might also be interpreted in such a manner as to give reality to the conventional distinction made in the paper between the dimensions of perpendicular lengths. For if there was any validity or significance in the distinction between temporal and spatial dimensions, there was just as much validity and significance in the distinction between the dimensions of lengths measured in three mutually orthogonal directions.

Mr. T. Smith disagreed from the author's classification of area as a quantity having no *sense*. In an indicator diagram containing loops it was necessary to give opposite algebraic signs to the areas separated by a point of self-intersection of the curves. Similarly the algebraic sign, or sense, of an angle had to be taken into account. It was true that quantities depending on $[L]^3$ were scalar, but the idea of direction was implicit in them; thus potential was scalar, but on differentiation it gave a directed force. In treating of rotation, the author considered circular motion only; his system would require some adjustment to fit the case of elliptic motion.

The author, in a communicated reply, regretted that he was unaware of the papers to which Dr. Thomas referred. He had since examined them. Professor Rücker's paper, however, did not anticipate his, and Professor S. P. Thompson's contribution to the discussion on it only did so to a very small extent. He was grateful to Dr. Thomas for drawing his attention to Mr. Williams's valuable paper. The dimensions of π with the author's notation was not 1, as stated by Dr. Thomas, but $[L_x]\,[L_y]^{-1}$. The dimensions of centripetal force were $[M]\,[L_x]^{-2}[L_y]^{-1}[T]^{-2}$, and the paper required a corresponding amendment. It was not correct, however, to say that therefore $[L_x]^2[L_y]^{-1} = [L_y]$. The *direction* of any quantity having the linear dimensions $[L_x]^2[L_y]^{-1}$ was the same as that of a quantity having the linear dimensions $[L_y]$ only; this followed from the line of reasoning. There was no justification, however, for equating $[L_x]^2[L_y]^{-1}$ to $[L_y]$.

In reply to Mr. Appleyard, the introduction of imaginary quantities would defeat one of the main objects in view, viz., clearness and simplicity, and would give no corresponding advantage. In reply to Dr. Temple, obviously the paper dealt with classical mechanics, and no question of relativity therefore arose. In reply to Mr. T. Smith, the sense of an area would be something different from the + and − applied to the two parts of an indicator diagram, which have arithmetical rather than physical significance. The objection to putting $([L_x]^2+[L_y]^2+[L_z]^2)$ in place of $[L]^2$ was that it introduced complications without any corresponding advantage.

Lantern Slides for Engineering Lectures.—Messrs. Ed. Bennis and Co., Limited, of 28, Victoria-street, London, S.W., will be pleased to lend lantern slides illustrating mechanical stokers and coal and ash-handling plant for lecture purposes.

Specification for Copper Cakes for Rolling—The British Engineering Standard Specification for Copper Cakes for Rolling (No. 201, 1924), has now been published, and it contains instructions on methods of testing and forms of test pieces. Copies may be had from the B.E.S.A., 28, Victoria-street, London, S.W.1, price 1*s.* 2*d.* post free.

Contracts.—The General Electric Company, Limited, have obtained the order from the South African Railways for supplies of Osram lamps for the ensuing 12 months. This is the first time for some years that the bulk of this large and important contract has found its way to an English manufacturer. The contract was lost to this country some years ago, and has since been held by foreign firms.—Messrs. John Thompson Water Tube Boilers, Limited, of Imperial House, Kingsway, London, have received a contract from Messrs. Vickers and International Combustion Engineering, Limited, for two vertical straight tube boilers each of 9,000 sq. ft. of heating surface and a working pressure of 275 lb. per square inch. Intended for service at the works of Synthetic Ammonia and Nitrates, Limited, at Billingham, Stockton-on-Tees, these boilers are to be fired with powdered fuel on the Lopulco System.—Messrs. Stothert and Pitt, Limited, of Bath, have secured orders for two electric travelling transporters, each fitted with a 7½-ton underhung revolving jib crane, from the Regent's Discharging Company, Limited, and also two electric four-motor travelling gantry cranes for the Fulham Gas Light and Coke Company, Limited.—The Engine Works Department of Messrs. Sir W. G. Armstrong, Whitworth and Co., Limited, have secured a contract from the Dundee Harbour Trust, for the supply and erection of a new steel bridge caisson for the entrance of the Camperdown Dock, at Dundee. The caisson, which is to replace an existing one, is to be delivered and set in position within five months from the date of placing of the contract. The caisson will be built at the Company's Walker Shipyard and towed to Dundee.—Orders have just been received from a Transvaal municipality for 2,500 M type meters, and from a Cape municipality for 3,000 inferential meters by Messrs. George Kent, Limited, of London and Luton.—Contracts for 250 wagons have just been placed by the London, Midland and Scottish Railway with the following firms: Metropolitan Carriage and Wagon Company, Limited, 100; Midland Railway Carriage and Wagon Company, Limited, 50; Hurst Nelson and Co., Limited, 100. The wagons, which are to have steel underframes and wood-lined tops, will be 27 ft. in length and of 20-ton capacity.

BELT AND MOTOR-DRIVEN HIGH-SPEED PLANING MACHINES.

CONSTRUCTED BY MESSRS. C. REDMAN AND SONS, LIMITED, ENGINEERS, HALIFAX.

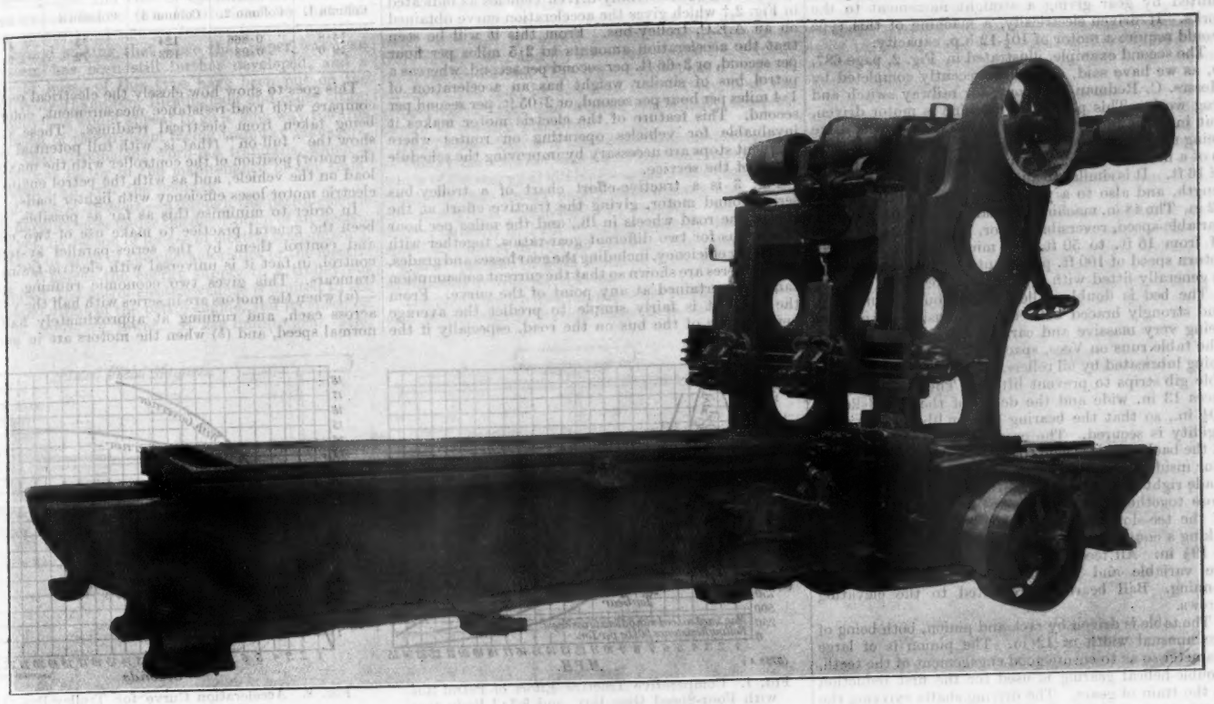


FIG. 1. 13-FT. BELT-DRIVEN FOUR-SPEED PLANING MACHINE.

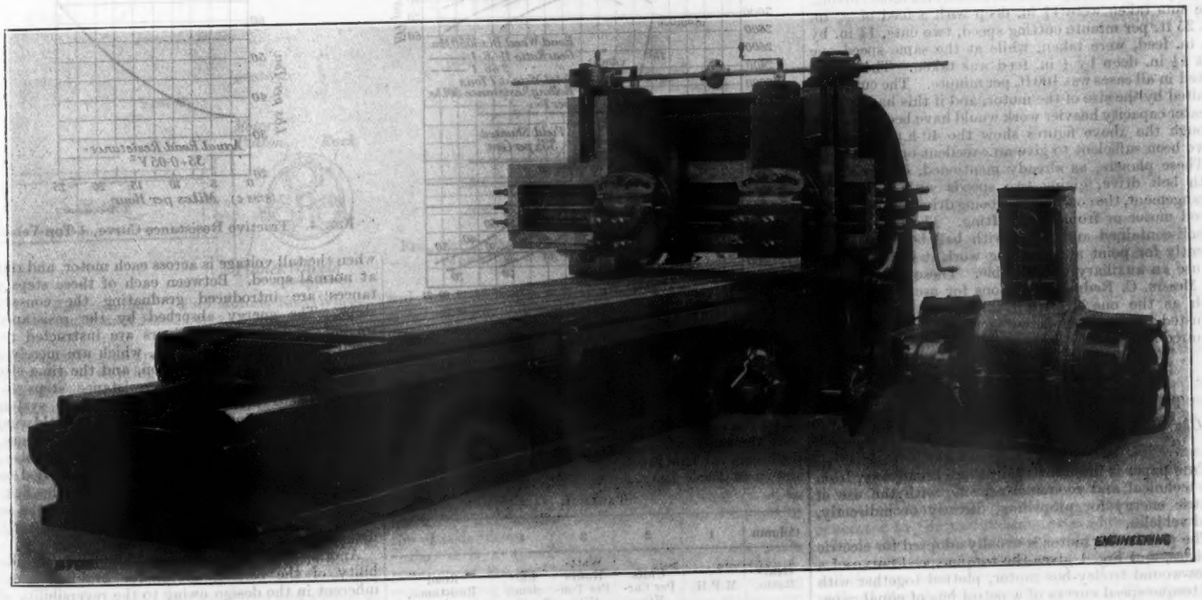


FIG. 2. 16-FT. MOTOR-DRIVEN PLANING MACHINE FOR POINTS AND CROSSINGS.

BELT AND MOTOR-DRIVEN HIGH-SPEED PLANING MACHINES.

Two good examples of modern planing machines are illustrated in Figs. 1 and 2, on this page. Both these machines are by Messrs. C. Redman and Sons, Limited, Parkinson-lane, Halifax, and are typical of the firm's belt-driven and motor-driven machines of this class. The first of our illustrations shows the belt-driven machine, while the second is a reproduction of a photograph of a machine specially built for planing work in connection with points and crossings.

The belt-driven machine has a length of table of 13 ft. between the suds dishes, and a length of bed of 19 ft. 6 in. The bed is very heavy, being 21 in. deep, and strongly braced. The Vees are centred 23 in. apart, the table having a width of 32 in. The maximum width and height of the work taken on the machine is 36 in. by 36 in. The bed is long enough to prevent excessive overhang of the table. The latter is deep and is ribbed longitudinally and crosswise; it is finished with Tee slots planed out of the solid. The machine is intended for maximum output with belt drive. The arrangement provides for four cutting speeds of from 30 ft. to 60 ft. per minute, obtainable by means of the four-speed cone belt pulleys, to be seen above the cross rail and housings, on which pulleys the belt can be shifted while the machine is running by means of the handwheel on the end of the slanting spindle outside the near housing. A constant return speed of 120 ft. per minute is provided.

The cross slide is of double-box section, the depth of the slide at the faces being 12½ in. The face of the housings is 7 in. wide. The tool boxes on the cross-slides are arranged to swivel, and automatic feed is provided in all directions. A third tool box is fitted on one of the housings, arranged for automatic vertical feed. This has slides of sufficient length to enable the tool box to work safely with considerable overhang. A sensitive friction-clutch, power-elevating motion enables the operator to set to fine limits. The elevating screws are fitted with ball bearings. All table gears

are of steel, and are double helical up to the pinion and rack, the latter being 4½ in. wide. The main drive is by two belts on to aluminium pulleys, reducing inertia and momentum and allowing the belts to pick up quickly. The belts can be operated from either side; they are shifted by gear giving a straight movement to the forks. If driven electrically, a machine of this type would require a motor of 10½-12 h.p. capacity.

The second example, illustrated in Fig. 2, page 687, is, as we have said, a machine recently completed by Messrs. C. Redman and Sons, for railway switch and frog work. This particular machine is motor driven, but in other forms it is belt driven, a four-belt drive being used, giving two cutting speeds. The illustration is of a machine 48 in. wide, capable of planing a length of 16 ft. It is similar to another size for cutting a 12 ft. length, and also to a pattern having a width of only 42 in. The 48 in. machine is usually fitted with a 40 h.p. variable-speed, reversible motor, giving cutting speeds of from 15 ft. to 50 ft. per minute, with a uniform return speed of 100 ft. per minute. The 42 in. machine is generally fitted with a 35 h.p. motor.

The bed is double walled throughout, 19 in. deep, and strongly braced between the housings, the latter being very massive and carried down to the ground. The table runs on Vees, spaced 33 in. apart, the ways being lubricated by oil rollers. It is fitted with adjustable gib strips to prevent lifting. The housings have faces 13 in. wide and the depth of the cross slide is 20½ in., so that the bearing is very liberal and great rigidity is secured. The cross slide itself is stiffened at the back, and it is held to the housings by plates with four inside and four outside bolts. The two heads are made right and left-handed, so that they can be brought close together. The tool boxes are of steel, and are of the tee-slot type, very wide, and capable of each taking a couple of tools. The vertical feed of the slide is 19½ in. All feeds for horizontal and vertical cuts are variable and reversible, while the machine is running. Ball bearings are fitted to the elevating screws.

The table is driven by rack and pinion, both being of the unusual width of 12 in. The pinion is of large diameter so as to ensure good engagement of the teeth. Double-helical gearing is used for the first reduction in the train of gears. The driving shafts carrying the gearing are provided with deep spiral oil runners. An idea of the capabilities of the machine may be obtained from the following figures, furnished by the makers: At a speed of 37 ft. per minute, with two tools cutting, the cuts taken were 1¼ in. deep with a feed of $\frac{1}{16}$ in. At 25 ft. per minute cutting speed, two cuts, 1¼ in. by $\frac{1}{16}$ in. feed, were taken, while at the same speed one cut 1¼ in. deep by ½ in. feed was taken. The return speed in all cases was 100 ft. per minute. The cuts were limited by the size of the motor, and if this had been of greater capacity heavier work would have been possible, though the above figures show the 40-h.p. motor to have been sufficient to give an excellent output.

These planers, as already mentioned, can be fitted with belt drive, giving two speeds with a four-belt arrangement, the countershaft being driven by constant-speed motor or from line shafting. The countershaft is self-contained and fitted with ball bearings. Frequently for point and crossing work it is the custom to use an auxiliary tilting table. These are arranged by Messrs. C. Redman and Sons for use on machines such as the one described, hinged at one end and adjusted by means of screw jacks at the other to the required angle. This is an easily-detachable accessory.

THE ELECTRIC ROAD VEHICLE.*

Its Characteristics and its Economic Field of Usefulness.

By D. E. Batty.

This paper is intended to deal in a broad way, from the technical and economic aspects, with the use of electric energy for propelling, directly or indirectly, road vehicles.

The plain series motor is usually adopted for electric vehicles, and Fig. 1 gives the torque-speed curve of a series-wound trolley-bus motor, plotted together with the torque-speed curves of a petrol bus of equal capacity, to show how the normal curve of the electric motor follows the performance of the petrol engine with a four-speed gear-box.

It is essential in a road vehicle, especially one operating in hilly districts, to have a motor that has a wide range of torque and speed, and in the petrol car this is effected by means of a gear-box. In the same way the already wide range of the series-wound motor can be increased by weakening the magnetic field, which has the effect that for the same torque the speed is increased, or for the same speed the torque is increased. This effect is shown in Fig. 1, where at 9 miles per hour 50 per cent. of the field current is shunted. It will be observed that this increases the maximum full-load speed on the level from 14 miles per hour to 18 miles per hour.*

The natural result of the high starting torque given by the series-wound motor is shown by the rapid acceleration of electrically-driven vehicles as indicated in Fig. 2,† which gives the acceleration curve obtained on an A.E.C. trolley-bus. From this it will be seen that the acceleration amounts to 2·5 miles per hour per second, or 3·66 ft. per second per second, whereas a petrol bus of similar weight has an acceleration of 1·4 miles per hour per second, or 2·05 ft. per second per second. This feature of the electric motor makes it invaluable for vehicles operating on routes where frequent stops are necessary by improving the schedule speed of the service.

Fig. 3 is a tractive-effort chart of a trolley-bus series-wound motor, giving the tractive effort at the rim of the road wheels in lb., and the miles per hour of the bus for two different gear-ratios, together with the motor efficiency, including the gear losses and grades. The amperes are shown so that the current consumption can be ascertained at any point of the curve. From the chart it is fairly simple to predict the average performance of the bus on the road, especially if the

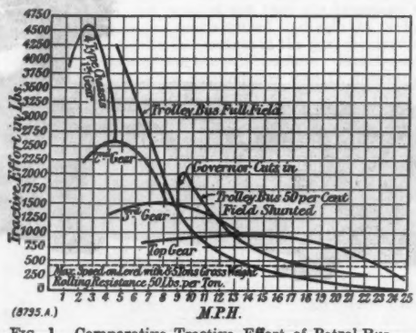


Fig. 1. Comparative Tractive Effort of Petrol Bus with Four-Speed Gear-Box, and 9·3:1 Reduction and Trolley-Bus with 7·25:1 Reduction.

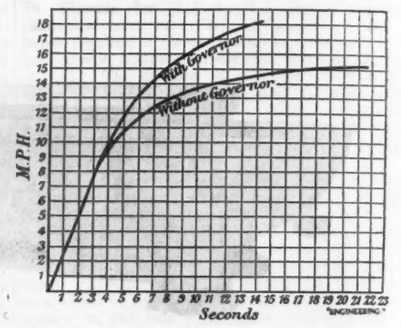


Fig. 2. Acceleration Curve for Trolley-Bus of 5 Tons Unladen Weight.

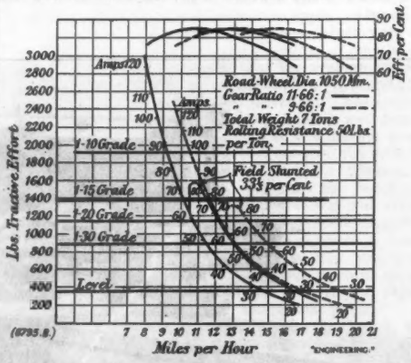


Fig. 3. Tractive Effort Curve, A.E.C. Trolley-Bus.

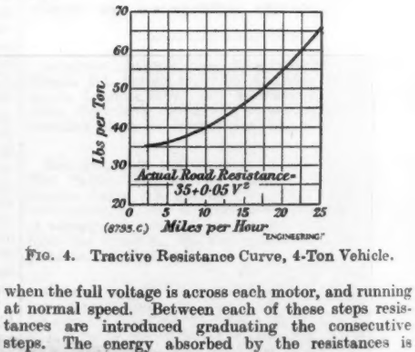


Fig. 4. Tractive Resistance Curve, 4-Ton Vehicle.

contour of the route and service schedule are known, so that a fairly close estimate of the units consumed can be arrived at. The rolling resistance has been taken at a round figure of 50 lb. per ton.

If we analyse this curve, taking the figures of performance on the level, we arrive at the conclusions shown in Table I.

Table I.

Column	1	2	3	4	5
Gear-Ratio.	M.P.H.	Units Per Car-Mile.	Watt-Hours Per Ton-Mile.	Efficiency Per Cent.	Road Resistance, lb. per ton.
11·66	14·8	0·91	130	74	48 Full field.
9·66	17·0	0·91	130	76	49·4 Full field.
11·66	16·6	0·904	129	76	49 Shunted field.
9·66	19·0	0·894	128	79	50·5 Shunted field.

Practical road tests have shown that for speeds between, say, 15 to 20 miles per hour, the total road resistance of an average bus with solid rubber tyres on a good macadam road in still air is about 50 lb. per ton. In this connection Fig. 4 is a tractive-effort curve taken from Mr. Conradi's book on "Mechanical Road Transport," and if the above tabulation is corrected for road resistance from this curve it is found that the figures for 14·8 miles per hour and 19·0 miles per hour, Table I., will be modified (the other figures remaining the same) as per Table II.

Table II.

Column 1.	Column 2.	Column 3.	Column 4.	Column 5.
14·8	0·866	124	74	45·8
19·0	0·93	133	79	52·5

This goes to show how closely the electrical readings compare with road-resistance measurement, column 5 being taken from electrical readings. These curves show the "full-on" (that is, with full potential across the motor) position of the controller with the maximum load on the vehicle, and as with the petrol engine, the electric motor loses efficiency with lighter loads.

In order to minimise this as far as possible, it has been the general practice to make use of two motors and control them by the series-parallel system of control, in fact it is universal with electric trains and tramcars. This gives two economic running speeds —(*a*) when the motors are in series with half the voltage across each, and running at approximately half the normal speed, and (*b*) when the motors are in parallel when the full voltage is across each motor, and running at normal speed. Between each of these steps resistances are introduced graduating the consecutive steps. The energy absorbed by the resistances is wasted, and therefore drivers are instructed not to dwell on the resistance steps, which are merely steps to smooth out the acceleration, and the time element while passing through the resistance steps is not great. There are, therefore, with this system of control, two running speeds, or three if the field windings are shunted. The alternative method is to use one motor with rheostatic and field shunt control. This has the advantage of simplicity, and if carried out to take full advantage of the shunting of the field the economy of running will be equal to that of the series-parallel control. It has two running speeds, or three if the fields are shunted in two steps.

Another feature of electric vehicles lies in the adaptability of the electric motor for braking, which is inherent in the design owing to the reversibility of the electric motor. This effect is quite independent of the source of supply of electric current, the only requirement being that the armature of the motor should be revolving, and that the main connections should be short-circuited through a resistance. The greater the speed the more powerful is the effect, and the greater must be the resistance put in circuit to keep the braking within reasonable limits; this form of braking is very powerful, and has to be used with discretion, and is not often used on electric road vehicles owing to the excessive stresses that can be put on the running mechanism. The author suggests that a compromise could be made in cases where electric braking is considered to be desirable in hilly districts, by having front-wheel brakes operating directly on the front wheels and energised from the revolving motor. By this means the braking effect would be distributed over all four wheels, and would be in addition to the

* Abstract of a paper read before the Institution of Automobile Engineers on November 12, 1924.

* See also Proc. I.A.E., vol. xvii, Part I, page 246.
† See also Proc. I.A.E., vol. xvii, Part I, page 245.

ordinary mechanical brakes necessary for holding the vehicle when stationary.

The Trolley-Bus.—The various types of trolley-bus, their advantages and cost of operation, have already been discussed before this Institution,* so that the present author need not go further into the question here, beyond stating that since that paper was read the system has been still further developed, and a number of buses of this type have been put on the road in Wolverhampton, Birmingham and other cities. The trolley-bus would appear to go a long way towards the solution of the problem facing tramway managers, namely, that of replacing worn-out tramrails, which is an important factor in the maintenance of our tramway systems all over the country.

Petrol-Electric Systems.—Although the petrol-electric vehicle hardly comes under the description of an electric vehicle yet, by reason of its use of electric transmission, it partakes of some of the characteristics of the electric vehicle. Whereas the energy supply to a trolley-bus is unlimited, the petrol-electric vehicle is limited to the maximum output of the petrol engine, and its speed on grades is, therefore, lower. It has infinite gear ratio, at a lower speed. The motor is identical with the generator, with the exception that the field coils are series wound instead of compound wound.

The controller and reversing switch consist of (*a*) a reversing switch having 12 tramway contact fingers, with screw adjustments, mounted on an insulating base, on which is carried a drum heavily insulated from the spindle, and (*b*) a multiple-contact controller for speed regulation. The engine, which has a bore and stroke of 115 mm. by 150 mm. respectively, is of the poppet-valve type, and follows the usually accepted design of modern practice.

The Thomas Electro-Mechanical Transmission System.—This sytem does not depend on the conversion of the whole of the energy available from the petrol engine, but transmits that energy partly mechanically and partly electrically. It includes two entirely mechanical drives, namely, at half, or approximately, half-engine speed and direct drive (top speed). The intermediate "gears" partake of both kinds of drive by adding or subtracting torque electrically.

The plant, shown diagrammatically in Fig. 5, consists of a petrol engine, driving through an epicyclic gear, direction (*i.e.*, in the same direction as the engine). It will be obvious from Fig. 5 that as the revolutions of No. 1 now increase, the speed of the cardan shaft will also increase until its speed equals that of the engine shaft, and, at this point, the epicyclic gear can be locked. After locking, the field of No. 2 can again be weakened until its voltage falls below that of the back e.m.f. of No. 1, when the current will die to zero and cannot build up again, the vehicle then being driven wholly mechanically.

This form of electric transmission has great possibilities from the point of view of efficiency, silence and smooth running, but suffers, like most electrical replacements of gear-boxes, from the weight and size of apparatus required. Research in the direction of the magnetic qualities of steels may do much to remove this disability in the future.

Gill and Chaviara Patent Variable-Speed Transmission Mechanism.—This system embodies the use of the homopolar type of electric generator and motor, and is at present in the experimental stage, and, as far as the author is aware, has not yet been applied to a road chassis, though he has seen an experimental

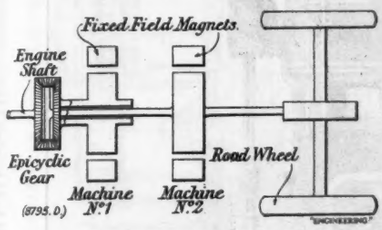


Fig. 5. Thomas Transmission.

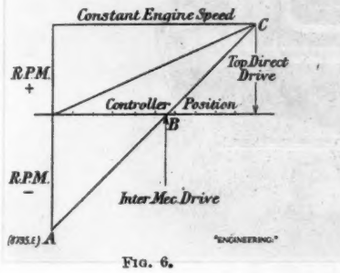


Fig. 6.

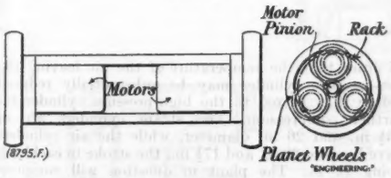


Fig. 7. "Electromobile": Two Motors, Rear-Wheel Drive, Sun and Planet Final Drive on Internal Rack.

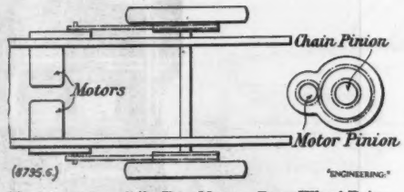


Fig. 8. "Orwell": Two Motors, Rear-Wheel Drive, Chain with Helical Gear Reduction.

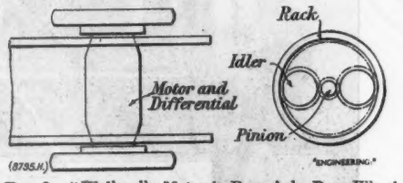


Fig. 9. "Walker": Motor in Rear Axle, Rear-Wheel Drive to Internal Rack with Differential.

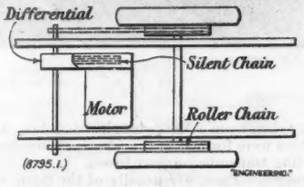


Fig. 10. "General Vehicle Company": Chain from Motor to Countershaft, thence by Chain.

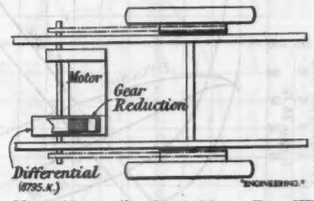


Fig. 11. "Clayton": Single-Motor Rear-Wheel Drive, Spur-Gear Reduction, Through Differential, Final Chain Drive.

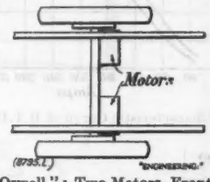


Fig. 12. "Orwell": Two Motors, Front-Wheel Drive on Swivel axles, Single-Reduction Driving on to Internal Rack.

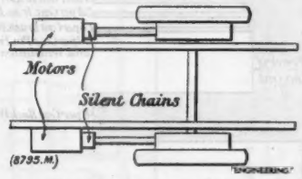


Fig. 13. "Electricars": Two Motors, Rear-Wheel Drive, Motors in Frame, Chain-Drive to Side Shaft and thence by Bevels.

and can adjust engine speed to road speed to give the best efficiency of working. On the other hand, owing to the double conversion of energy from mechanical to electrical, and from electrical back to mechanical, the overall efficiency is probably less than that of a good gear-driven vehicle. The electrical efficiencies of each electrical unit will vary from 90 per cent. to 80 per cent., so that the overall electrical efficiency will vary from 81 per cent. to 64 per cent., and this without allowing for the rear-axle worm-drive efficiency which, of course, is common to the gear-driven bus. Makers, however, claim that in actual practice there is very little to choose between the two systems in petrol consumption, and, at the same time, they obtain all the advantages of the electric drive with its smoothness and silence of action. The electrical transmission acts automatically as a sprag, and serves effectually to prevent the chassis from running backwards, except at a very low speed, if unexpectedly brought to a standstill, without the brakes being applied, while negotiating a steep gradient.

The Stevens Petrol-Electric Chassis.—This consists in the main of a standard petrol chassis with a final worm drive and differential in the rear axle, the electrical plant consisting of a dynamo, motor and controller, taking the place of the gear-box and clutch. The dynamo is coupled directly to the engine, and is of the four-pole interpole type, compound-wound, and provided with commutating poles. It is capable of delivering 230 amperes to 300 amperes at a voltage of 110 to 80 respectively, at from 1,100 r.p.m. to 1,200 r.p.m., or any smaller output within the above limits and two series-wound electrical machines, which can either of them, act as a generator or a motor. No. 1 machine is mechanically coupled to one of the crown wheels of the gear, the other crown wheel being, coupled directly to the engine; for the purpose of this example the crown wheels are illustrated as of equal size. Both machines are electrically connected in series. The floating pinions, or planet wheels, are coupled to No. 2 machine, the shaft of which is carried through the armature, and drives, by means of a cardan shaft, the final drive of the rear axle (through worm or bevel gearing). By this arrangement, if the epicyclic gear is locked solidly, the engine drives directly on to the axle. The magnets of both machines are fixed to the chassis frame.

Fig. 6 is a speed diagram, showing three main positions of the controller, A, B, and C. Position A, engine running light, armature of No. 1 machine running idle in opposite direction, the chassis being stationary. The circuit is then closed through the controller, and No. 1 machine builds up as a generator, delivering current at low voltage to machine No. 2. Power is then being delivered in two ways to the cardan shaft: first, mechanically, due to the reaction torque caused by No. 1 machine acting as a generator; and, secondly, electrically, due to No. 2 acting as a motor, the combined torque starting the vehicle. As No. 1 machine builds up, it speeds up No. 2 machine, and, in doing so, itself slows down, letting the engine drive more mechanically until position B is reached, when No. 1 machine comes practically to rest and the chassis is driven mechanically at half speed through the epicyclic gear. At this point the field connections of No. 2 machine are reversed, and this motor becomes a generator supplying current to No. 1, causing it to come to rest, and then to revolve as a motor in the opposite machine at work. A homopolar dynamo is one which generates a direct current without the use of a commutator at a very low voltage and high current; in fact, the voltage is so low that no special insulation is required. Owing to this fact the "winding," or, rather, the copper conducting circuit, can be cast solidly into the steel magnets. The motor and generator have to be constructed close together, so as to minimise as far as possible the length of path of the electric current, a form of construction which makes a very compact torque converter. The main difficulty in the design which the patentees claim to have overcome is the transfer of the very large currents from the generator to the motor armatures while they are revolving at equal or different speeds. The flux paths of both generator and motor are of annular formation, and they are both inter-linked with an annular current path of the shortest possible length. The flux and current paths are divided circumferentially to form the rotors and stator, so that while one intersection of the flux and current for each machine is stationary, the other is movable. With this arrangement the movement of the rotors causes cutting of the magnetic flux by the current path with the consequent production of an e.m.f. The gaps between the stationary and the rotating portions of the current path are metallically completed by a film of mercury, and the whole current path is of such low resistance that the small e.m.f. produced gives rise to a very large current. The field magnets are separately excited, and, by varying the relative strength of fields, speed variation is obtained. The overall efficiency is said to be very high, ranging from 80 per cent. to as much as 96 per cent. according to size and output of machine.

The Battery Vehicle.—This vehicle retains the

* See Proc. I.A.E., vol. xvii, Part I, page 215.

advantages of the electric drive, but is limited in its sphere of action by the battery capacity. In spite of this limitation, the development and use of these vehicles have increased of recent years, due to improvements in the storage system and to the recognition of the field in which the electric battery can be most economically employed. In America, the development has been far greater than in this country, in spite of the lower price of petrol and the lower capital cost of the petrol cars in that country. Mr. Mitchell, in his address as Chairman of the Scottish Centre of the Institution of Electrical Engineers, in November, 1923, stated that "in America one can obtain twelve Ford cars for the price of one electric-battery vehicle."

Owing to the limitations placed on the battery vehicle, as stated above, designers have to seek every possible means to make the efficiency of the motor, and also that of the transmission to the road wheels, as high as possible. The result of this is that, among

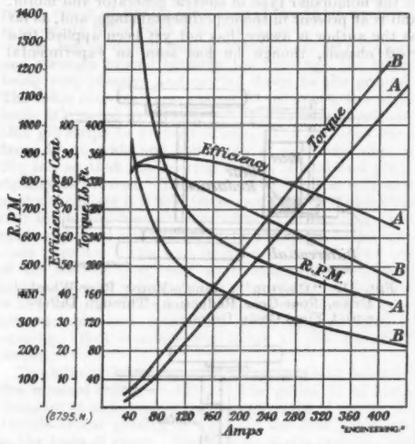


FIG. 14. Characteristic Curve of B.T.H. Motor.

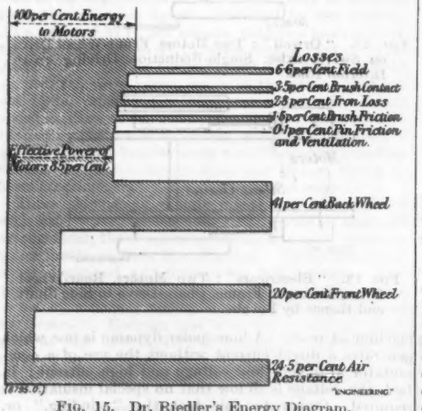

100 per Cent. Energy to Motors
Losses
6·6 per Cent. Field
3·5 per Cent. Brush Contact
2·8 per Cent. Iron Loss
1·8 per Cent. Brush Friction
0·1 per Cent. Pin Friction and Ventilation.
Effective Power at Motors 85 per Cent.
41 per Cent. Back Wheel
20 per Cent. Front Wheel
24·5 per Cent. Air Resistance
(8795.G)
"ENGINEERING"

FIG. 15. Dr. Riedler's Energy Diagram.

manufacturers there is no standard form of chassis design, as in the petrol chassis, partly on account of the extraordinary flexibility of the electric-motor drive. There are, for instance, types in which motors drive through spur gearing on to the front wheels, those in which motor units form the road wheels, those in which motors drive by chains on to the rear wheels, &c. For the sake of clearness and comparison, these constructions, which are taken from road vehicles ranging from 1 to 10 tons load-capacity, are shown diagrammatically in Figs. 7 to 13. From a study of these constructions, it is to be noted that designers appear to look upon single-motor drives as favourably as two-motor drives. Some of the designs, where the motor or motors are embodied in the axle, must necessarily have the disadvantage of heavy unsprung axle weights, though battery vehicles are so slow that this is not so detrimental as it first appears. These diagrams show how each designer had attempted to get the maximum efficiency of transmission.

The motors themselves, as has been said, must be designed with a view to maximum efficiency, and they are generally rated for continuous operation, with a permissible temperature rise of 65 deg. C. They are also capable of taking 300 per cent. overload without sparking for short periods. Fig. 14 is a typical curve of a B.T.H. Company G.E. 1027 automobile motor, while Fig. 15 is an energy diagram given by Dr. Riedler, taken from a Mercedes electromobile, in which the motors were formed in the wheels themselves, thus eliminating transmission-gear losses.

Controllers.—These are usually of the drum type, as used on tram cars, and are operated by a lever on the driver's right hand. In the Orwell chassis, which has a two-motor drive, there are two drums, the main drum being operated by a lever, while the auxiliary, or rheostatic, drum is operated by a pedal, the action of which is exactly analogous to the operation of the clutch on a petrol vehicle, and enables the driver to coast in traffic without interfering with the main controller. On the General Vehicle Company's cars, which employ the single-motor drive, the controller is of the continuous torque type, and gives five forward and two reverse speeds. Another efficient method of control, especially for slow speed in traffic, is that of grouping the battery in two sections, so as to obtain half the voltage, but this method is not generally used, owing to the liability to discharging the two halves of the battery unequally.

(To be continued.)

STEAM-DRIVEN TWO-STAGE AIR COMPRESSOR

CONSTRUCTED BY MESSRS. BROWETT, LINDLEY AND CO., LIMITED, MANCHESTER.

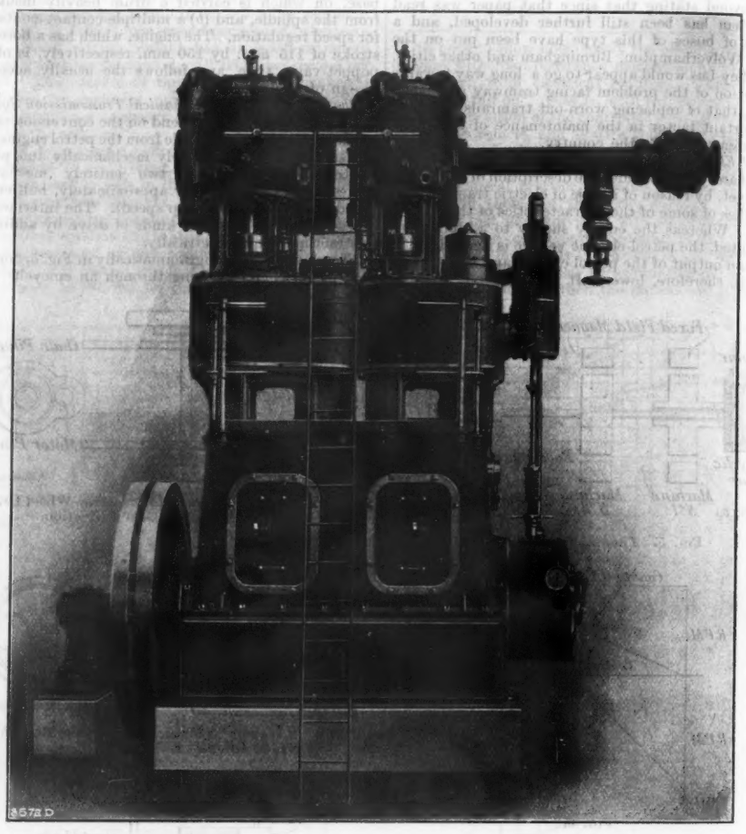


FIG. 1.

TWO-STAGE STEAM-DRIVEN AIR COMPRESSOR.

THE accompanying illustrations on this page and opposite show a steam-driven air compressor made by Messrs. Browett, Lindley and Co., Limited, of Sandon Works, Patricroft, Manchester, which was one of the items displayed on the stand of the firm at the British Empire Exhibition. Essentially this plant consists of a vertical compound steam engine, above which the cylinders of the two-stage air compression have been mounted. The arrangement is shown in Fig. 1, which is a general view of the complete set. To obtain efficiency in working, an air compressor must be provided with an effective cooling system, and it will be observed from Figs. 2 and 3 that complete water jacketing for the cylinder barrels and ends has been provided. In addition, a large intercooler is installed, in order that the temperature of the air leaving the low-pressure cylinder may be substantially reduced before it is passed to the high-pressure cylinder for further compression. The steam cylinders are of 16½ in. and 26 in. diameter, while the air cylinders have bores of 28 in. and 17½ in., the stroke in each case being 13 in. The plant in question will compress 2,000 cub. ft. of free air per minute to a pressure of between 80 lb. and 100 lb. per square inch. It is supplied with steam at a pressure of 120 lb. to 150 lb. per square inch and the speed of running is 270 r.p.m.

The general design of the steam engine part of the equipment is the same as the well-known enclosed type of forced lubrication steam engine made by the firm, a recent example of which was also shown at the British Empire Exhibition and was illustrated and described in ENGINEERING of August 29. This compound steam engine is fitted with piston valves for both the high and low-pressure cylinders, and the running is controlled by a centrifugal governor fitted on the end of the crankshaft. In general, throttle governing is used, but a combination of this system with variable expansion working can also be provided, when exceptional economy is desired and the gear for this is shown in use in Fig. 2. For a description of the details of construction of this engine reference may be made to the article previously referred to. As the air cylinders are above the steam ones the simple piston rods of the engine are replaced by those of longer length shown in Figs. 2 and 3, in order that both air and steam pistons may be located on common rods.

The covers of the steam engine cylinders are formed in the bases of the distance pieces which support the air cylinders. These air cylinders are of simple design, and it will be observed that the jackets are of large capacity and give an unrestricted path for the flow of the water. The valves which control the passage of the air into and away from the cylinders are of the Rogler-Hoerbiger type. They are made from discs of tempered steel cut in such a way as to give a covering ring for the series of ports and a flexible connection to

STEAM-DRIVEN TWO-STAGE AIR COMPRESSOR.

CONSTRUCTED BY MESSRS. BROWETT, LINDLEY AND CO., LIMITED, ENGINEERS, MANCHESTER.

Fig. 2.

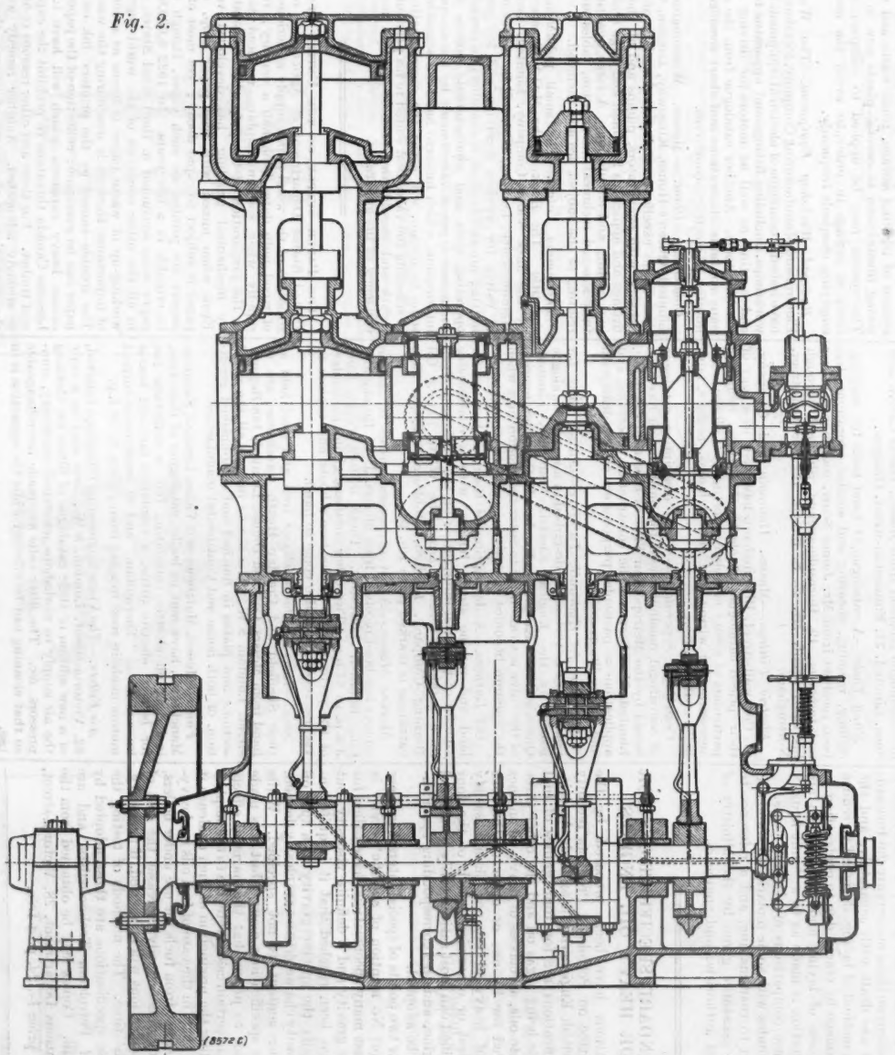
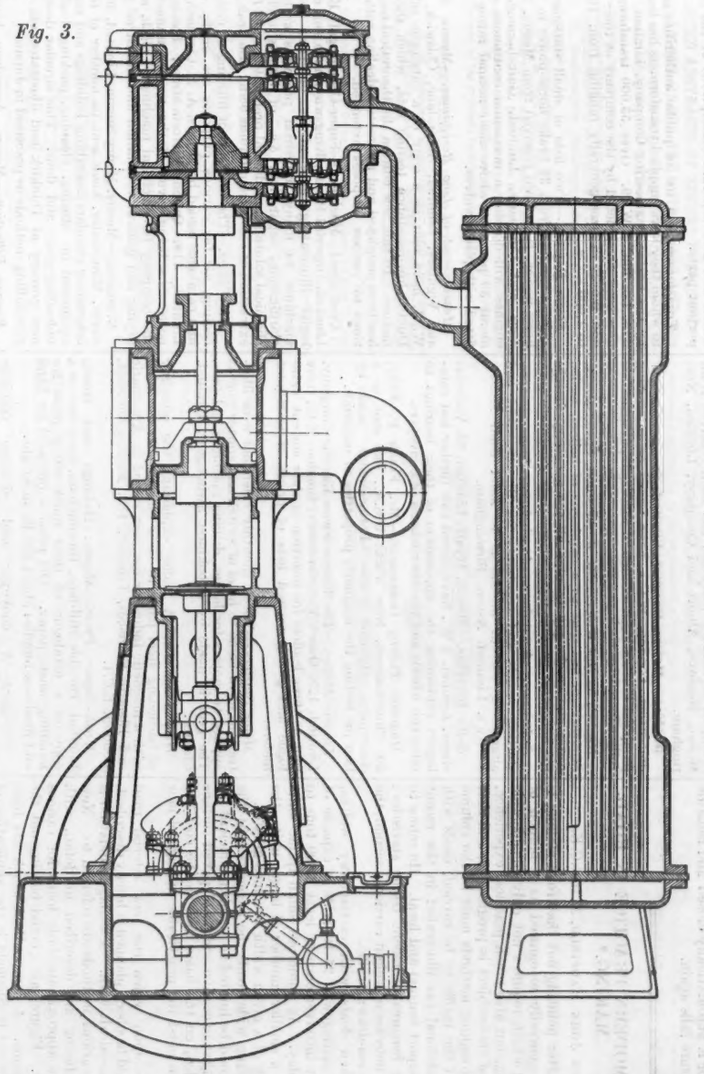


Fig. 3.



the point of fixture. Being light and having but a small lift, they show little tendency to wear, even after they have been in service for long periods. With their seats, these valves may be removed at any time for inspection. The intercooler shown in Fig. 3 is provided with a series of vertical tubes connected to plates at the top and foot, and the headers are so arranged that the water has a path, from inlet to outlet, consisting of four passes between the two ends of the intercooler. A baffle plate in the air space of the intercooler ensures that the air must come into contact with the tubes throughout their length in its downward and upward flow.

For use with these steam-driven air compressors Messrs. Browett, Lindley and Co., Limited, have devised an automatic control system, which comes into operation to prevent working under full-power conditions when there is little or no demand for compressed-air supply. Whenever the production of compressed air exceeds the demand the pressure in the air main will rise. This increased pressure is used to raise a plunger, in a small cylinder, the rod of which is connected to a throttle valve in the steam system, so that the speed is automatically reduced to a value which will meet the requirements of the altered demand conditions. Whenever a greater amount of air is required the pressure in the air main falls and the plunger, relieved of the extra pressure, again falls to

its normal position. Should the pressure in the air main exceed a certain predetermined amount, due to the lack of demand for air, it is arranged that the air inlet of the compressor is automatically closed and remains so until the pressure falls again.

NOTES ON MODERN PRACTICE IN ROAD-MAKING.*

By Walton John Hadfield, M.Inst.C.E.

The author, after pointing out that road-making is becoming more generally recognised as a branch of civil engineering which requires not only considerable technical training, but also much practical experience, that knowledge of this subject is progressive, and that the basis of road-making methods must be the volume and character of the traffic to be carried, deals with traffic figures, national (as illustrated in the recent Ministry of Transport census) and local. He refers to two outstanding features of recent traffic statistics: first, the general increase of weight carried; second, the diminution of horse-drawn traffic.

The paper then deals with carriageway widths, showing that a carriageway 24 ft. wide is capable of carrying without inconvenience at least 3,000 tons to 4,000 tons per day. As numerous small traffic units are replaced by a smaller number of larger units, the tonnage capacity of a given width becomes greater.

While advocating wide roads, he suggests that the carriageways should be limited to a width sufficient for the traffic, and that excessive widths of paved surface should be avoided, on the basis that as the cost per mile increases, so must the practicable mileage of new roads decrease.

The principle upon which the new arterial road system of Sheffield has been planned is briefly described.

Foundations are dealt with. A strong foundation is advocated, and various methods are referred to. New methods of surfacing are described in detail, with references to the approximate daily loads for various types of surface. Figures are quoted bearing out the author's conclusions. A new method which has been extensively practised in Sheffield is the application of clinker asphalt to tramway tracks.

The questions of camber and safety are associated, and certain conclusions on these matters are put forward.

Concrete roads are dealt with separately, and the paper describes a method of laying, designed to reduce the liability to damage by cracks due to contraction.

Comparative costs of laying and maintenance are cited, and a suggestion is made as to a "unit figure" upon which to base comparisons of highway costs.

The paper concludes with some remarks on standardisation as applied to road-making, and a reference to the effect of the assistance given by the Ministry of Transport to road authorities and engineers.

BRITISH STANDARD SPECIFICATIONS FOR FUELS FOR HEAVY OIL ENGINES.

Four specifications have been prepared by the Sectional Committee on Petroleum Products recently set up by the British Engineering Standards Association. The specifications are for four grades of fuel oil, the first grade being a gas oil and the other three being non-distillate oils, all classes of heavy-oil engines thus being catered for by one or other of the four grades. Users of heavy-oil engines should satisfy themselves, by test or otherwise, which of the four grades of oil specified can most satisfactorily be utilised in any given engine, and the corresponding specification should then be adopted.

There are one or two points of special interest in these specifications:—(*a*) No mention of specific gravity is made. In the past many specifications have called for a definite specific gravity and a definite viscosity, but the conclusion has been reached that it is quite unnecessary to specify the specific gravity of a fuel oil provided the viscosity characteristics are clearly defined.

(*b*) The sulphur content is not specified. While drawing up these specifications every effort was made to obtain evidence to prove that the harmful effects attributed to oils in certain cases were due to the sulphur in the oil. Pending the production of such evidence it has been decided that, in the case of fuel oils for heavy-oil engines, as distinct from fuels for use under boilers, a test for sulphur unnecessarily increases the cost of the oil. The specifications will be revised, if necessary, in twelve months' time. The methods of testing the oil given in these specifications are those adopted by the Institute of Petroleum Technologists, and are described in detail. Copies may be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, London, S.W. 1, price 1*s.* 2*d.* post free.

* Abstract of a paper to be read before the Institution of Civil Engineers on Tuesday, November 18, 1924.

CATALOGUES.

Laundry Machinery.—A small sheet circular illustrating examples of laundry machines has been received from Messrs. Manlove, Alliott and Company, Limited, Nottingham.

Welding.—Messrs. Barimar, Limited, 18, Lamb's Conduit-street, London, W.C.1, have issued an interesting pamphlet illustrating a number of welding repairs successfully effected by their process.

Heating by Hot Water.—Mr. J. Attwood, Foster-street, Stourbridge, has sent us a catalogue of boilers, tanks, water and smoke piping and all the necessary fittings for hot-water heating installations.

Switchgear.—A catalogue of switchgear, fuses, starters, starting panels and regulators for direct-current and alternating current motors is to hand from Messrs. Verity's, Limited, Aston, Birmingham.

Roller Bearings.—Messrs. Hyatt, Limited, 56, Victoria-street, London, S.W., have issued two further leaf catalogues explaining the application of their bearings to mine-tub wheels and the idler wheels of conveyors.

Magnetic Testing Instrument.—Mr. Frank P. Fahy, 50, Church-street, New York, U.S.A., has sent us a descriptive catalogue of the "Permeameter" made by him for testing the magnetic properties of materials.

Electric Meters.—The Edison Swan Electric Company, Limited, 125, Queen Victoria-street, London, E.C., have sent us three leaflets for insertion in their current catalogue and giving revised lists of prices of watt-hour meters.

Motor Starters.—Three monthly calendars with illustrations have come to hand of switch and starter gear as applied to motors for lathes, drilling machines and fans, The gear is made by Brookhirst Switchgear, Limited. Chester.

Heat Treatment.—A leaflet explaining the economy of hardening steel parts in their electric furnace fitted with a magnetic indicator has been issued by Automatic and Electric Furnaces, Limited, 173, Farringdon-road, London, E.C.1.

Waste-Paper Press.—Messrs. Hollings and Guest, Limited, Thimble Mill-lane, Birmingham, have sent us a copy of a catalogue of their quick-acting press for bundling waste paper. The press is operated by hand and produces bundles about 200 lb. in weight.

Conveyors.—A conveyor and elevator specially designed for transporting bundles of newspapers from the machine room to the dispatch room is illustrated in a catalogue received from Messrs. David Carlaw and Sons, Limited, 31, Finnieston-street, Glasgow.

Hand Tools.—A catalogue of hand tools for tapping, drilling, reaming, shearing and similar operations, has been received from Mr. James Scarr, tool manufacturer and importer, 19, Burnside-avenue, Sheffield, through his sales agent, Mr. E. S. Smith, 12, Fretwell-street, Nottingham.

Electric Fittings.—Messrs. Donovan and Company, 47, Cornwall-street, Birmingham, have sent us a copy of their priced catalogue of electrical fittings, including particulars of a very complete assortment of all the small accessories for wiring, and also of lamps, heaters, fans, bells, switches, &c.

Centrifugal Separators.—A full descriptive catalogue of centrifugal machines used for purifying oil has been issued by the Metropolitan Vickers Electrical Company, Limited, Manchester. The construction, operation and applications to particular purposes are clearly dealt with and amply illustrated.

Air Valve for Hydraulic Turbines.—An air valve for reaction water turbines is described in a special catalogue issued by the English Electric Company, Limited, Queen's House, Kingsway, London, W.C. The function of the valve is to allow air to enter the suction tube when the vacuum becomes excessive.

Oil Burners.—A description of their oil burners for land and marine steam boilers, with a considerable amount of technical information on the subject, is given in a catalogue received from the White Patent Oil Burning Company, Limited, Hebburn-on-Tyne. This catalogue is marked price 10*s.* 6*d.*

Marine Motors.—A list of revised prices of marine motors has been received from Messrs. J. W. Brooke and Co., Limited, Lowestoft. These motors range from 3 h.p. to 65 h.p. Two other circulars, giving particulars of the performances of the firm's boats and engines in various races, have also come to hand.

Steel.—Lists of the stocks of iron and steel held at their Sheffield and Cradley Heath warehouses are to hand from Messrs. Cox and Danks, Limited, 168 Regent-street, London, S.W. The stocks include all the usual sections and plates in finished and semi-finished condition, of both home and Continental manufacture.

Fans.—Messrs. Matthews and Yates, Limited, Swinton, Manchester, have sent us leaflet catalogues of their fans, including an electric ventilating fan, a multivane fan for belt or electric drive, a combined fan and heater known as a "Thermofan," and of continuous-current motors made in sizes ranging from $\frac{1}{6}$ h.p. to 50 h.p.

Air Filters.—The Visco Engineering Company, Limited, 82, Victoria-street, London, S.W., have sent us a copy of a new edition of their catalogue of filters for cleaning the air supply to workshops, electrical machinery, compressors, &c. The filter cells are made interchangeable so that cleaning can be effected while the apparatus is in use.

Transformers.—Messrs. Ferranti, Limited, Hollinwood, Lancashire, have issued three new catalogues of oil-immersed static transformers, externally operated oil-immersed tapping switches and oil-testing equipment. These catalogues are clearly written and illustrated and give separate descriptions of the more important parts.

Transformers.—A list of public authorities and firms to whom they have supplied transformers has been issued by the Foster Engineering Company, Limited, Wimbledon, London, S.W.19. Over 53,000 transformers have now been constructed by the company at their Wimbledon Works in sizes generally ranging from 100 kv.-a. to 1,000 kv.-a.

Steam Engines.—Two lists of small stationary steam engines ranging from 3½ brake horse-power to 35 brake horse-power, have been received from Messrs. Marshall, Sons and Company, Limited, Gainsborough. These engines will develop a maximum continuous power of about 50 per cent. above their normal rating and are fitted with piston valves.

Measurement of Low Resistances.—Messrs. Evershed and Vignoles, Limited, Acton-lane, Chiswick, London, W. 4, have sent us a copy of a catalogue relating to Ducter low-resistance testing sets, which they manufacture. In this new edition the theoretical explanation has been simplified and the section dealing with applications to various purposes extended.

Centrifugal Machines.—Super-Centrifugal Engineers, Limited, Imperial House, Kingsway, have sent us a catalogue illustrating applications of their centrifugal machines to many industrial processes such as the clarification, separation, &c., of liquids such as oil, chemical solutions, medicinal preparations and foods, the extraction of solids from liquids being also dealt with.

Air Filters.—The methods of filtering or cleaning and cooling, air for various purposes are briefly discussed in a catalogue issued by Messrs. A. B. Cleworth and Co., Limited, 118, Queen Victoria-street, London, E.C., particulars being given of the type manufactured by the company for electrical machinery, cloth, and other drying and general ventilation and industrial purposes.

Granaries.—Messrs. Henry Simon, Limited, 20, Mount-street, Manchester, have sent us another of their very interesting circulars describing buildings and mechanical equipment for storing, cleaning, packing, loading and unloading grain and flour. This circular describes the new granary at Dunkirk and illustrates old and new rice-milling methods as practised in Japan.

Sewage Filtration.—Messrs. Aerseocon Limited, 17, Store-street, London, W.C., have sent us a catalogue containing a detailed description of their bio-mechanical system of treating sewage, trade waste and water, and giving illustrations of several plants now in operation. The system may be applied to comparatively small flows of sewage in order to avoid the necessity for emptying cesspools frequently.

Railroad Workshop Equipment.—The Westinghouse Electric and Manufacturing Company, Pittsburgh, U.S.A., have issued a catalogue of electrical equipment for railway workshops, including fittings and apparatus for lighting and heating as well as motors for driving hoists and machine tools. Another catalogue from the same company contains illustrations and short specifications of a number of electric locomotives.

Condensing Plant.—Messrs. Worthington-Simpson, Limited, Queen's House, Kingsway, London, W.C., have sent us an excellent catalogue of surface and jet condensers, with evaporators, pumps and all the necessary fittings and apparatus for small and large scale condensing, cooling and circulation. A large quantity of carefully-selected technical information, tables and formulæ relating to the subject are also included.

Thermionic Valves.—The small publication bearing the title "The Book of the M.O.V.," recently issued by the M.O. Valve Company, Limited, Brook Green, Hammersmith, London, W.6, will be welcomed by users of valves for wireless receiving and low-power transmitting apparatus since it contains in a convenient form operating data and characteristic curves of all the commoner types of valves made by the company. This information, which hitherto has been somewhat troublesome to obtain, will assist the discriminating amateur in selecting the valve best suited to his particular requirements and should thus enable him to improve the efficiency of his apparatus.

The Paper Supply of the United States.—The United States Department of Agriculture regards the situation of the wood-paper supply as serious. The use of wood pulp dates back half a century; it increased rapidly when sodium sulphite replaced caustic soda in the preparation of the pulp while maceration merely by mechanical grinding has developed very much. Even when mixed with true paper pulp, wood pulp paper is subject to rapid decay; yet most of the newspapers are printed on such paper, though they begin to crumble in a few years. In 1922 8,000,000 tons of paper were consumed in the United States, more than in all the other countries of the world together. The working-up of waste paper is hence as much a matter of importance there as it was during the war over here. The trouble caused by the printers' ink on the waste paper can be overcome; collection of the paper, however, causes heavy expenses which will have to be faced, because Canada threatens to prohibit the export of pulp and timber. For these and other reasons re-afforestation is strongly advocated. Another remedy would lie in the restriction of the waste of paper; that was practised in this country during the war, but the waste of paper soon became worse than ever again.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the communicators are given in italics.

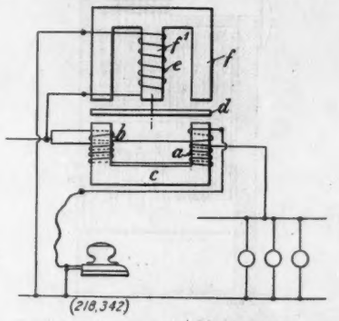
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

ELECTRICAL APPARATUS.

218,342. W. M. Mordey, Westminster, and The Electrical Apparatus Company, Limited, South Lambeth. Electricity Meters. (3 *Figs.*) February 1, 1923.—The invention relates to electricity meters capable of measuring and recording, simultaneously or successively, the amount payable at different rates for lighting, heating, power or other purpose, the current for which the lower rate is to be paid being caused to pass through a portion of a series resistance less than that through which the current to be paid for at a higher rate passes. In such meters, according to the present invention, the currents for which different rates are to be charged are arranged to flow through separate series windings connected in parallel, or through separate series windings connected in parallel and each having a series resistance in parallel with it, the separate series windings being inductively arranged in relation to a rotary element of the meter with which a shunt or E.M.F. winding is also inductively arranged, and the number of turns of the winding, or the value of the series resistance, through which the lower price current is to flow being proportionately less than the number of turns, or the value of the series resistance, through which the higer price current is to flow. All the windings are permanently connected up so that the meter is available for use during all periods, the use of switches for altering the ratio of charge for different periods of the diurnal day thus



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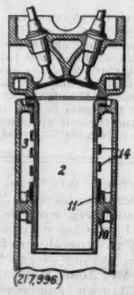
being avoided. The construction shown is suitable for a two-rate alternate current motor meter of the induction type. *a* is the higher rate current winding, and *b* the lower rate current winding, these windings, having different numbers of turns, being mounted on a U-shaped magnetic core *c* arranged at one side of a rotary disc armature *d*, whilst *e* is the shunt or E.M.F. winding of the meter mounted on the centre polar limb *f*1 of an E-shaped magnetic core *f* arranged to act upon the opposite side of the rotary disc armature. Each of the current windings *a* and *b* may, as shown, be divided into two portions mounted respectively on the two polar limbs of the U-shaped magnetic core *c*, but they could, if desired, be mounted on the intermediate portion of the core. The meter is adapted to register the full money value, in units or otherwise, payable for lighting or other purpose for which the higher rate is to be charged, and at less value, say one-third of the higher value, in units or otherwise, payable for power or other purpose for which the lower rate is to be charged, and therefore will register the total amount to be paid by the consumer, it being assumed that the constant for the meter has been correctly determined for the current to be paid for at the higher rate. The meter will then correctly indicate the amount payable for total energy consumed. (*Accepted July* 16, 1924.)

GAS ENGINES, PRODUCERS, HOLDERS, &c.

217,996 S. Smith, Gunnersbury, London, and A. C. Cars, Limited, Thames Ditton. Internal-combustion Engine Cylinders. (3 *Figs.*) March 27, 1923.—The invention relates to that type of cylinder of internal-combustion engines in



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which the cylinder proper or the cylinder sleeve 2 is in direct contact with the cooling fluid and is made separately from the jacket 3 which encloses the cooling fluid, this cylinder sleeve 2 being clamped in position at the cylinder head end and having a sliding support 10 at a point spaced away from this end whereby the cylinder sleeve 2 will be free to expand to a greater or less degree than the jacket if local differences of temperature arise and/or the co-efficients of expansion of the materials are different. According to the invention, the joint for the sliding support comprises a stuffing box within the jacket 3, a hydraulic or other packing 11 disposed within the stuffing box and a spring 14 or its equivalent acting upon this packing 11 to form a fluid-tight joint between the jacket 3 and the cylinder sleeve 2. (*Sealed.*)

218,002. Sir W. G. Armstrong, Whitworth and Co., Limited, Newcastle-upon-Tyne, and B. Irving, Newcastle-upon-Tyne. Oil Fuel Burners. (4 *Figs.*) March 29, 1923.—According to the invention, a burner consists of two coaxial tubes, the inner tube *a* for the passage of oil and the outer tube *b* for the passage of steam. The inner tube *a* is of one internal diameter throughout and is screw-threaded at one end *c* to receive a screw cap *d*, which is held in position by a screw locking nut *e*, and the screw cap *d* is internally tapped to receive the outer

Fig. 1.

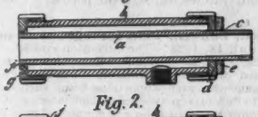
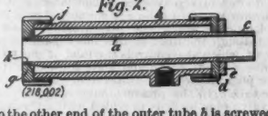


Fig. 2.



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tube *b*. On to the other end of the outer tube *b* is screwed a similar cap *g*. This end of the inner tube *a* is not screw-threaded and extends through a hole *j* bored in the cap *g* slightly larger in diameter, say one-hundredth of an inch, than the end of the inner tube *a*. Alternatively, this end of the inner tube *a* may be reduced in external diameter and the hole in the cap *g* may be such as to form a good joint with the outside end of the inner tube *a*, which is fluted at *k* (Fig. 2). In the first case, steam can pass through the clearance between the two tubes and in the second case through the flutings. (*Sealed.*)

217,969. T. J. Ashley, Bath, and Aldridge and Ranken, Limited, London. Apparatus for the Manufacture of Coal Gas. (5 *Figs.*) March 19, 1923.—The invention relates to apparatus for the manufacture of coal gas, in which the gas passes from a group of retorts through valve-controlled branch connections into a stand pipe, down which liquid, such as ammoniacal liquor, is caused to descend in the form of spray. The invention provides an improved arrangement and construction of disc valves in the stand pipes, one of which valves in each stand pipe is normally removed bodily and is only intended to be inserted in the pipe at rare intervals when it is required to isolate the gas and foul mains, whilst the others, which control the branch connections between the retorts and stand pipes, are intended to remain in the stand pipes and are so arranged and

Fig. 1.

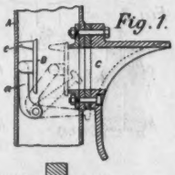
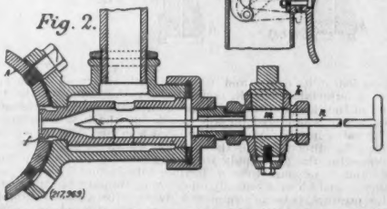


Fig. 2.

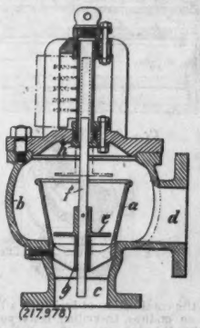


(217,969)

constructed that when in the open position they allow the falling liquor to pass freely downwards. According to the invention, each of the branch pipe controlling disc valves D is pivotally mounted inside the stand pipe A on the upper end of a rocking arm *a*, operated from the outside and moved into the closed position against a vertical seating. On the rear face of the valve are provided projections or stops *e*, whereby it is kept in a vertical position when open, or with its face parallel to the axis of the stand pipe A, so that there is no tendency to deflect the falling liquor into the retort through the connecting branch C. The spraying apparatus *f* is applied to the side or top of the stand pipe A and is provided with a testing plug cock *k*, which is formed with a passage *m* arranged to permit a clearing rod *n* to be inserted and pushed through the spraying nozzle when the cock is open. (*Sealed.*)

HYDRAULIC MACHINERY.

217,978. The Pulsometer Engineering Company, Limited, Reading, and J. Björnstad, Reading. Apparatus for Indicating the Flow of Liquid through Pipes. (7 *Figs.*)

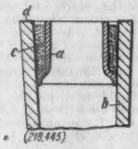


(217,978)

March 23, 1923.—The invention relates to apparatus for indicating the flow of liquid through pipes wherein a disc *c* is mounted to move in a truncated passageway *a* located within a casing *b*, having inlet and outlet branches *c*, *d* arranged at an angle to one another, and the disc *c* arranged in the passage between such branches is provided with an indicating device in the form of a rod *f* arranged to work within a sighting chamber in communication at one end with the interior of the casing *b* but closed at the other end. The invention has for its object to provide that the disc *c* and indicating rod *f* are constrained to move in a truly axial direction in the cone *a*. For this purpose, guiding means *g*, *h* are provided both below and above or on each side of the disc *c* for causing the disc *c* and the indicating rod *f* carried thereby to move in a truly axial direction. The indicating rod *f* is extended through the disc *c* and works through guides *g*, *h* above and below or on each side of the disc and co-axial with the disc *c* and cone *a*. (*Sealed.*)

MINING, METALLURGY AND METAL WORKING.

218,445. G. W. Naylor, Denby Dale, near Huddersfield, and J. F. Naylor, Denby Dale, near Huddersfield. Ingot Moulds. (4 *Figs.*) May 23, 1923.—The invention relates to ingot moulds without sockets or enlarged rims at their upper ends and more particularly to refractory linings for the tops of moulds of the type in which a space is left between the lining and the mould, the space being filled with cinders, coke or the like. According to the invention, the lining is smaller than the upper part of the mould, so that the mould has not to be recessed



(218,445)

to support the lining, the breeze or coke being placed between the lining and the surface of the mould. A space between the lining *a* and the mould *b* is obtained by turning the lower end of the lining outwards, its edges bearing against and registering with the taper of the mould. The lining is held in position by a number of metal strips bent to shape for that purpose. The space *c* between the lining and the mould is filled with small coke, refuse, cinders or similar heat-retaining material in order to maintain the heat of the metal in the mould and is in contact with the lining for a considerable period. (*Sealed.*)

217,072. Head, Wrightson and Co., Limited, Thornaby-on-Tees, R. S. Benson, Thornaby-on-Tees, and H. Clark, London. Screening and Washing Coal. (2 *Figs.*) July 11, 1923.—The invention relates to mechanism of the type in which a reciprocating movement is imparted to a conveyor or screen such as is frequently used for conveying, screening or washing coal. According to the invention, a countershaft has keyed to it a piece to which an eccentric loose on the countershaft can be connected at two diametrically-opposite points. A is part of the countershaft, B is an eccentric loosely-mounted thereon and C is the

Fig. 1.

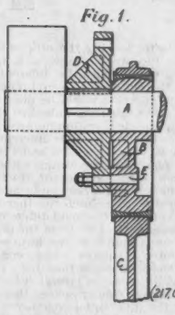
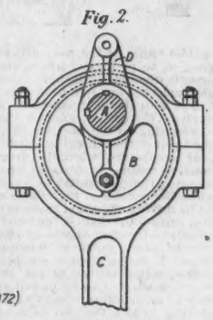


Fig. 2.



(217,072)

eccentric rod which actuates the conveyor. D is a piece keyed to the shaft A and having in it two holes opposite to one another. A hole is also formed through the eccentric so that a tapered pin E can be inserted through the hole in the eccentric into one of the holes in the piece D and secured by nuts. Thus when it is desired to reverse the direction in which the material is conveyed all that is necessary is to remove the pin E, to turn the shaft A through 180 deg. independently of the eccentric, so that the hole in the piece D which was unoccupied comes into line with the hole in the eccentric and to re-insert the pin. (*Sealed.*)

218,019. W. M. Burdon, Bellshill, Lanarkshire, M. M. Burdon, Bellshill, Lanarkshire, and Burdons, Limited, Bellshill, Lanarkshire. Oil Fuel Furnaces. (4 *Figs.*) April 3, 1923.—The object of the invention is to provide an oil

Fig. 1.

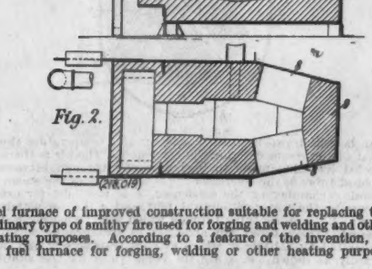
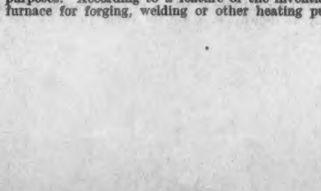


Fig. 2.



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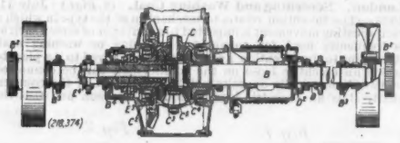
fuel furnace of improved construction suitable for replacing the ordinary type of smithy fire used for forging and welding and other heating purposes. According to a feature of the invention, an oil fuel furnace for forging, welding or other heating purpose

comprises a combustion chamber 2 at the rear of the furnace, a working chamber 3 at the front of the furnace greater in height than the combustion chamber 2 and having its floor on substantially the same level as the floor of the latter, a crown for the combustion chamber formed by a bridge 4 stretching across the furnace and forming the floor of a passage 5 leading rearwardly from the upper part of the working chamber 3 to a regenerative chamber 6 behind the combustion chamber and formed as part of the rear of the furnace. According to another feature of the invention, the furnace is formed with working openings 8 in the side walls of the working chamber 3 and the front portion or front bricks 9 are removable so as to enable the corners of a plate to be heated and other heating to be done that would not be easily accomplished merely by means of the side openings. If desired, the top 10 of the furnace may be hinged or may be removable. Further, the walls of the working chamber 3 may converge towards the front of the furnace for the purpose of concentrating the heat and facilitating the heating of long bars, angles and the like. (*Sealed.*)

MOTOR ROAD VEHICLES.

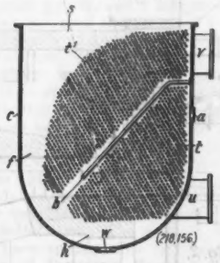
218,374. Armstrong, Siddeley Motors, Limited, Coventry, and H. M. Bonhaud, Coventry. (1 *Fig.*) April 3, 1923.—The invention relates to tractors or similar vehicles of the kind in which a loosely mounted winding drum is provided on an axle transverse of the vehicle, and can be clutched thereto so as to be in operation either while the vehicle is travelling or when the latter is at rest. According to the invention, the drum is mounted upon one part of a divided differentially driven shaft, the outer ends of which are indirectly connected through clutches and gearing with the tractive means, the inner ends being provided with clutch mechanism to lock them together at will and to provide a solid drive for the drum. The winding drum A is mounted loosely upon its shaft B and is driven through differential mechanism C. The drum A is adapted to be clutched to the shaft through the dog clutch D, D2. The shaft B may drive the road wheels through reduction gearing B2. The diameter of the drum A is so chosen that the hauling speed of the drum is equal to the peripheral speed of the tractive means. The change speed gear for the vehicle transmission is situated between the drum and the engine, and the hauling speed of the drum is always the same as the vehicle speed. To enable the drum to be operated with the vehicle at rest, clutches B^5 are provided between each part of the divided shaft B and the gear wheel B2. Thus when it is desired to operate the drum as a winch with the vehicle stationary, the clutches B^5 are withdrawn to free the drive to the road wheels. A clutch is also provided to enable the two parts of the shaft B to be locked to one another, and this in conjunction with the clutches B^5



enables either of the road wheels, after locking the differential gear, to be positively driven while the other is free, as is frequently desirable in making a sharp turn. With the differential gear unlocked and free to operate, the clutches B^5 would remain locked with the gear wheels B2, and steering would be done by applying the brake on one or the other side; the unbraked side accelerating to the same extent as the deceleration induced by the brake on the other side. Such a clutch to lock the differential gear also serves, when the drum is being used to assist the tractive means, to transmit the power to the drum without allowing the differential to transmit a reaction to the tractive means on one side of the vehicle which would otherwise be added to its driving effort and cause it to slip. To clutch together the two parts of the shaft B, the hub C^5 of one of the main differential wheels C2 is extended somewhat towards the hub C^5 of the other wheel C^4 and provides a housing for a clutch in the form of a sleeve E having splines on its outer periphery which engage corresponding splines in the extended hub portion C^5. This sleeve is adapted to be moved axially so as to project into the hub C^5 of the other wheel C^4 and engage similar splines therein, thereby to lock the two parts of the differential together. To operate this clutch, an axial recess B^4 is provided in the shaft B with which the clutch E is mounted, and within this recess slides a rod E^5 attached to the clutch and engaged by an operating collar E^4 sliding upon the shaft, the collar carrying a pin which extends through axial slots in the shaft to engage with the rod E^5. Thus, when the clutch E is withdrawn it is completely housed in the hub C^5 of the differential wheel C2. (*Sealed.*)

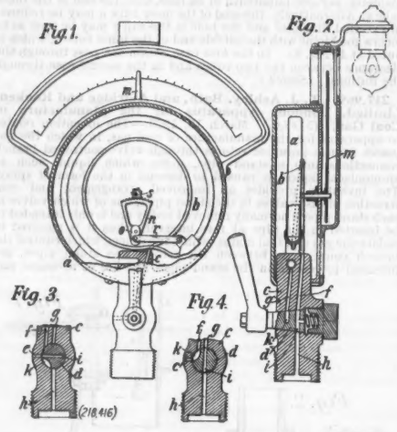
STEAM ENGINES, BOILERS, EVAPORATORS, &c.

218,156. G. & J. Weir, Limited, Cathcart, Glasgow, and J. G. Weir, Cathcart, Glasgow. Steam Condensers. (1 *Fig.*) September 10, 1923.—The invention relates to steam condensers of the surface type. According to the invention, a free passage is provided from the steam inlet—at the upper part of the condenser—to the bottom of the condenser, so that steam can pass down this passage and transversely across the bottom of the condenser, and in its transverse passage heat the water which rains through it, so that the water (condensate)



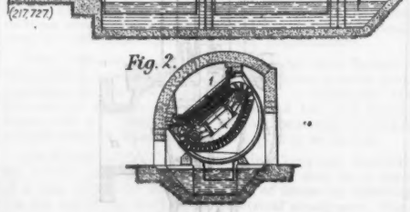
can be withdrawn from the condenser at a temperature close to that of the steam entering the condenser. The air is thereafter cooled by being made to pass upwardly through between the coldest tubes of the condenser. *c* is the casing of the steam condensing chamber of the condenser, *s* is the inlet for exhaust steam, *w* the water-withdrawal port, and *a* the air-withdrawal port. *t*, *t1* are the tubes through which the condensing water is passed. These tubes are arranged in two groups which are separated by a baffle *b*, which extends transversely and downwardly as shown. *u*, *v* are the connections for the admission and discharge respectively of the condensing water to and from a water box or header at one end of the condenser. There is another water box or header at the other end of the condenser, and the water is passed from the one to the other, first through the group of tubes *t*, below and to the right of the baffle and thereafter (in the reverse direction) through the group of tubes *t1*, above and to the left of the baffle. *f* is the free passage before referred to, extending from the exhaust steam inlet to a tubeless space *h* at the bottom of the condenser. The condensate collects at the bottom of this space *h*. The air-withdrawal port *a* is situated, as shown, under the connection of the baffle with the casing wall, and not far below the baffle so that air can gain access to the port only after passing through the group of tubes *t* through which the coldest condensing water passes. The arrangement is thus of a nature to obtain the lowest air temperature at the port *a*. The condensate falling from the tubes to the bottom of the condenser gets heated by steam which is in the top of the space *h* and entering therefrom into the spaces between the tubes *t* is practically at admission temperature. The conditions are thus conducive to obtaining high condensate discharge temperatures (through the port *w*). (*Sealed.*)

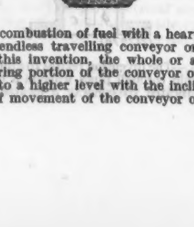
218,416. C. W. Bryant, Peterborough, and Peter Brotherhood, Limited, Peterborough. Pressure Gauges. (6 *Figs.*) April 18, 1923.—The invention consists in a pressure guage having a chamber connected to the source of pressure and provided with a controllable blow-through outlet, the general arrangement and proportions being such that the chamber may be efficiently scavenged. The interior of the free end of the Bourdon pressure tube *a* is connected by a flexible tube *b* with the block *c* on which the pressure tube itself is mounted, the outlet through the duct in this block being controlled by a finger valve *d*, which also controls the inlet of gas to the Bourdon pressure tube. Ducts *e*, *f*, *g* and *h* are formed in the block connecting the plug of the valve respectively to the atmosphere, to the flexible tube *b*, to the pressure tube *a*, and to the gas supply, while the valve plug itself is provided with a through duct *i* and a recess *k*. In order to connect the Bourdon tube *a* to the pointer *m*, according to one plan, a toothed sector *n* is pivotally



mounted at its centre and provided with an arm *o*, which may be of adjustable length, connected by the link *r* to the free end of the Bourdon tube, the sector engaging with a corresponding pinion *s* mounted on the spindle of the indicating finger. The valve in the closed position shown in Fig. 3 is turned in a clockwise direction into the position shown in Fig. 4, thereby connecting the gas supply to atmosphere by way of the ducts *h*, *i* and *g*, pressure tube *a*, flexible tube *b*, duct *f*, recess *k*, and duct *e*, and blowing out any oil or other combustible trapped in the pressure tube or connected ducts. By slowly continuing the movement of the valve, the duct *e* to the atmosphere is closed and the pressure tube *a* momentarily disconnected from the gas supply until re-connected by movement of the valve through 180 deg. In this way generation of heat by sudden compression of gas rapidly admitted can be avoided, continued movement of the valve in one direction automatically ensuring an efficient scavenging of the system. (*Sealed.*)

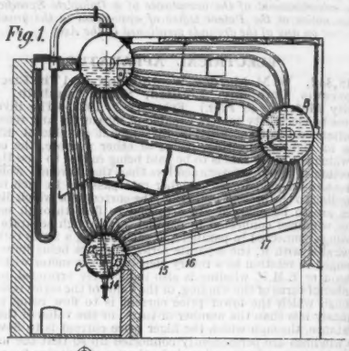
217,727. J. S. Atkinson, Westminster, London, and Stein and Atkinson, Limited, Westminster, London. Furnaces. (5 *Figs.*) May 14, 1923.—The invention has reference to the combustion of fuel in furnaces on hearths or fuel carriers consisting of endless travelling conveyors or belts.

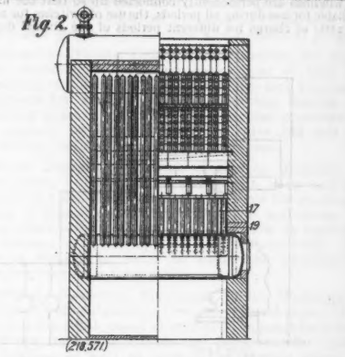




A furnace for the combustion of fuel with a hearth or fuel carrier consisting of an endless travelling conveyor or belt 1 has, in accordance with this invention, the whole or a portion of the upper or fuel bearing portion of the conveyor or belt 1 extending from a lower to a higher level with the inclination or slope in the direction of movement of the conveyor or belt, and with the point 30 at which fuel is supplied to the conveyor or belt and the point 29 at which ashes and clinker are discharged therefrom disposed so that fuel in its travel therebetween is subjected to two influences, one being due to the forward movement of the conveyor which lifts the fuel to a position at which its angle of repose is exceeded when it falls backward towards the lower level of the conveyor or belt, and the other being due to gravity which causes the fuel to move between the points of supply and discharge and in a direction at right angles to that of the movement of the conveyor of belt. (*Sealed.*)

218,571. A. Elliott, Chelsea, London. Water Tube Steam Generators. (3 *Figs.*) December 19, 1923.—In a water-tube steam generator in accordance with this invention, the rear water drum C is divided into two compartments 12, 13, each in communication with the front water drum B by a bank of tubes 15, 16, the front water drum B and the compartment 13 of the rear water drum C being also in connection with one another by downcomers or return tubes. The rear water drum C is divided into the

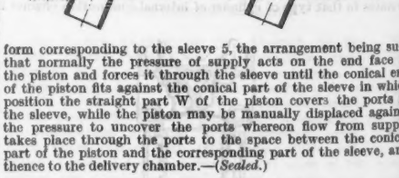




two compartments 12, 13 by an internal partition 14 and the banks of tubes 15, 16 connecting the rear water drum C with the front water drum B are divided by a partition or baffle 17 or partitions or baffles so that a vertical row 19 or vertical rows of tubes is, or are, formed at one or both sides of the steam generator, and is, or are, protected from heat action to serve as downcomers or return tubes to supply one compartment of the rear water drum from the front water drum.—(*Sealed.*)

MISCELLANEOUS.

215,273. N. W. Bancroft, Buenos Aires, Argentine Republic. Taps and Cocks. (4 *Figs.*) November 14, 1923.—According to the invention, the tap or cock is provided internally with a sleeve 5 spaced away from the tap body, the sleeve at the delivery end of the tap terminating in a hollow cone and having ports P_1 P_1 in the straight part thereof, the arrangement being such that the flow from supply to delivery is outside the straight part of the sleeve, through the ports and through the conical end to the delivery chamber of the tap, the flow through the tap being regulated by a piston 6 moving in and having a



form corresponding to the sleeve 5, the arrangement being such that normally the pressure of supply acts on the end face of the piston and forces it through the sleeve until the conical end of the piston fits against the conical part of the sleeve in which position the straight part W of the piston covers the ports in the sleeve, while the piston may be manually displaced against the pressure to uncover the ports whereon flow from supply takes place through the ports to the space between the conical part of the piston and the corresponding part of the sleeve, and thence to the delivery chamber.—(*Sealed.*)

MINING EDUCATOR.—We have received a copy of Part I of a new serial publication, with the title *Mining Educator*. The complete work is to be issued in 30 fortnightly parts by Sir Isaac Pitman and Sons, Limited, and is intended to provide useful instruction in all phases of modern mining as practised in this country. It is edited by Mr. John Roberts, M.I.Min.E., and a number of well-known engineers and scientists are included among the contributors. No previous knowledge has been assumed on the part of the reader, in the many subjects treated, and everything is presented in a very simple and clear way. The price of each part is 1*s.* 3*d.* net.